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Abstract

Artiodactyla is the most dominant mammal in the Udunga fauna, and more than 2000 specimens have been recognized in the fossil materials to date. In this small study we provisionally identified ten taxa, including four species of cervids and six species of bovids based on antler and horn morphology, but the identification operation has not yet been completed. Most of the artiodactyl specimens are of dental and bone fragments, so it is very hard to identify the taxa on the genus and/or species level. In order to classify the postcranial materials we tried the statistical analyses on four kinds of the hind limb bones, such as astragalus, distal tibia, calcaneus, and naviculocuboid. Although we could not get the sufficient result from this work, we classify the specimens into several groups. These analyses would be useful for higher taxa classification of fossil artiodactyls.

Introduction

The middle Pliocene Udunga fauna consists of the elements of the forest and glassland artiodactyls. Vislobokova et al. (1995) has preliminary classified the Udunga artiodactyls into seven species of two subfamilies (Table 1): *Axis shansius* and *Orchonoceros gromovi* (Cervinae), *Capreolus constantini* and "alcine sp." (Odocoileinae), *Antilospira zdanskyi* and *Gazella sinnensis* (Antilopinae), and *Ovis* sp. (Caprinae). Later Kalmykov and his colleagues considered there are at least six to ten taxa in the Udunga artiodactyls. However, their classifications were based on the several fragmentary specimens and far from the satisfaction. In this short report we examined relatively well-preserved postcranial materials, such as astragalus, distal tibia, calcaneus, and naviculocuboid, which are housed at the Southern Scientific Center (SSC), Russian Academy of Sciences (RAS), using the statistical analyses. Our result indicates that there are about ten groups of artiodactyls in the Udunga artiodactyls as Kalmykov suggested.

Materials and methods

Preliminary classification of the antlers and horns

Table 1. Artiodactyls of the Udunga fauna.

Cervidae
Cervinae
Axis shansius Teilhard and Trassaert 1973
Orchonoceros gromovi Vislobokova 1979
Odocoileinae
Capreolus constantini Vislobokova and Kalmykov 1995
Alces?
Bovidae
Antilopinae
Antilospira zdanskyi Teilhard and Trassaert 1938
Gazella sinnensis Teilhard and Piveteau 1970 (small form with curved horn)
Gazella sp. (large form with straight horn)
Gazella sp. (large form with curved horn)
Gazella sp. (small form with straight horn)
Caprinae
Ovis sp.

Among the artiodactyls specimens we first analized the antlers and horns for the preliminary classification. First, we measured 305 cervid antlers including 122 of *Capreolus*, 157 of *Axis* or *Orchonoceros*, small amount of "*Alces,*" and small cervid stored in SSC (Appendix 1, FIgure 3). *Capreolus* and *Axis*/*Orchonoceros* are distinguishable to use the measurements of the antler specimens (Figure 3). *Alces* is identified by its morphology because the basal antler measurements of *Alces* apparently exceed those of *Axis*/*Orchonoceros*. Teilhard and Trassaert (1937) referred that *Axis shansius* of the Pliocene of northern China has large and small form. The specimens of *A. shansius* are also plotted over a range of *Capreolus* and *Axis*/*Orchonoceros*. Three specimens of the small cervid fall within the range of *Capreolus,* but the morphological characteristics is distinguishable from *Capreolus*.

Second, we measured 63 bovid horns including five of *Ovis*, two of *Gazella* "A", one of *Gazella* "B", 36 of *Gazella* "C", ten of *Gazella* "D", and nine of *Antilospira* (Appendix 2, FIgure 4). Bovids horns are mush fewer than cervids antlers, but the state of the preservation is very well. Figure 4 shows the distribution of the measurements of basal parts of bovid horn. *Gazella* is categorized into four species. Most abundant species are *Gazella* C, which is a small form with curved horn. *Gazella* A is close in size to *Gazella* C, and has straight horn. Among the larger *Gazella, Gazella* D has a straight horn, while only one specimen of *Gazella* B has curved one. *Antilospira* is an intermediate form in size between large and small *Gazella*. *Ovis* tends to have narrow breadth and the size, resembling *Antilospira zdanskyi* and *A. robusta*. *Gazella sinensis* (Teilhard and Trassaert, 1938) is smaller than *Gazella* C. *Antilospira* of Udunga differs from *A. zdanskyi* and *A. robusta* of nothern China in the size and length/breadth ratio (Figure 4).

Brief description and comments on Udunga artiodactyls

CERVIDAE

Table 2. Numbers of the antler specimens of cervids.

	antler specimen
Capreolus	122
small cervid	6
Alces?	20
Axis / *Orchonoceros*	157

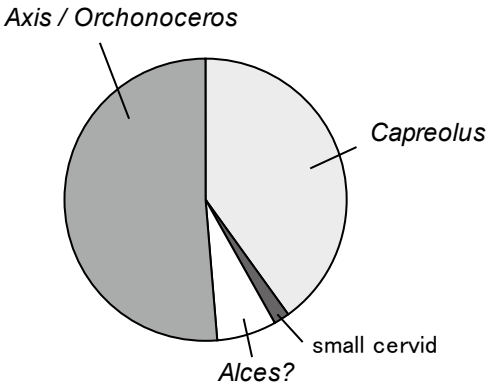

Figure 1. Percentage of the antler specimens of cervids.

Table 3. Numbers of the horn specimens of bovids.

	horn specimen
Ovis sp.	5
Gazella A	2
Gazella B	1
Gazella C	36
Gazella D	10
Antilospira	9

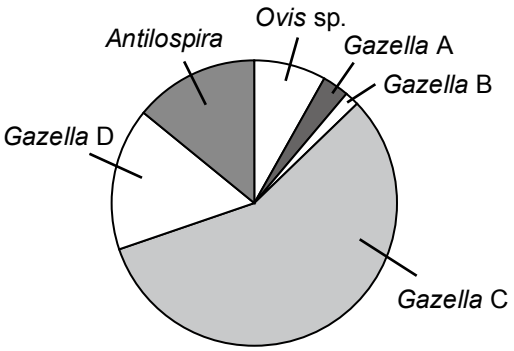

Figure 2. Percentage of the horn specimens of cervids.bovids

Cervinae

Orchonoceros gromovi

Orchonoceros gromovi was erected by Vislobokova (1979) based on the fossil specimen discovered from the late Pliocene of Shamar, Mongolia, and has been discovered from the early to late Pliocene of Transbaikal area. Vislobokova and Hu (1990) considered *Orchonoceros* is an ancestral group for *Praemegaceros* and was probably replaced by *Praemegaceros* in the early Pleistocene. *Orchonoceros* belong to the tribe Megacerini, and is smaller than other megacerine deer.

Axis shansius

Axis shansius was established by Teilhard Chaldin and Tassaert (1937) based on the fossil remains discovered from the Pliocene of Yushe, Shanxi Province, northern China.

Odocoileinae

Capreolus constantini

Capreolus, roe deer, is the smallest but most abundant artiodactyl in the Udunga fauna. The antler characteristically retains numerous tubercles especially on the inner and lower side of the beam base, as in extant species. Vislobokova et al. (1995) erected a new fossil species, *C. constantini*, based on a left frontal bone with antler broken off above the first bifurcation (GIN 987/294). The oldest fossil record of *Capreolus* is from the lower Villafranchian (MN

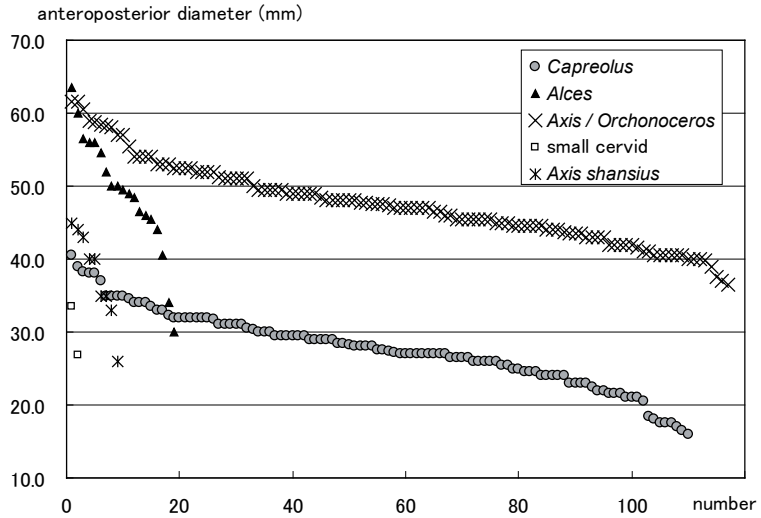

Figure 3. Measurements (mm) of cervids antlers. Ordered in the size of the anteroposterior diameter of the antler base

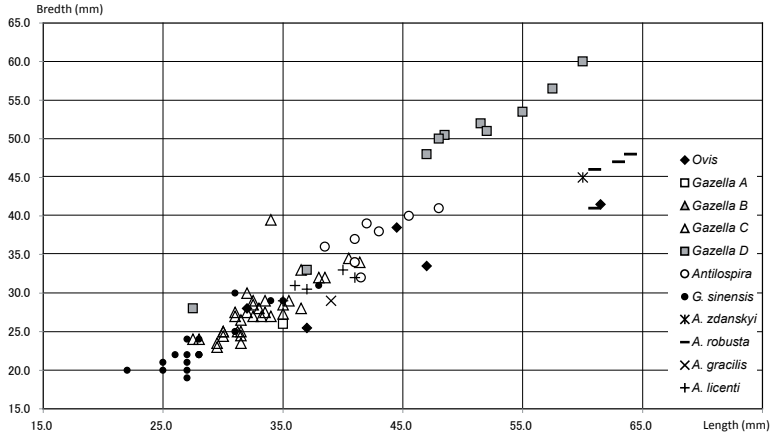

Figure 4. Bivariate plot of the diameter of horn base: length vs. bredth (mm).

16) in Moldavia (Budei02) and Slovakia (Hajnáčka) (Godina and David, 1973; Fejfar et al., 1990) and from the lower Pleistocene of Tunliu, Shanxi Province, northern China (Zong et al., 1982). Vislobokova and Kalmykov (1995) presumed that the ancestor of *Capreolus* was *Procapreolus wenzensis* from Węże I, Poland (Zone MN 15), which is slightly smaller than and has relatively shorter premolars than in *C. constantini*.

"Alcinae" gen. indet.

Although Vislobokova et al. (1995) mentioned an alcine species in the Udunga fauna, neither genus nor species was determined. They considered that this alcine is probably related to but slightly smaller than *Libralces gallicus* discovered from the Pliocene of France. *Libralces* is comparable in size with those of *Megaloceros*, giant deer with palmate brow. Most researchers regard *Libralces* is a relative of extant *Alces*, moose.

Vislobokova et al. (1995) listed three fragmentary frontals with antler bases as the referred material, but neither dental nor postcranial specimens was mentioned. In this study we identified a large-size, robust astragalus (Udg-4063) and distal tibia (Udg-4203) as an alcine deer. Compared with other specimens, the astragalus is very robust and extremely

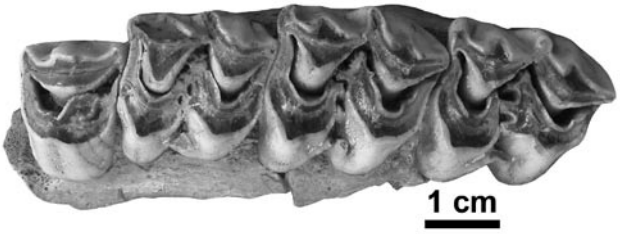

Figure 5a. Left maxilla preserving P^4-M^3 (Udg-5802) of *Axis shansius*.

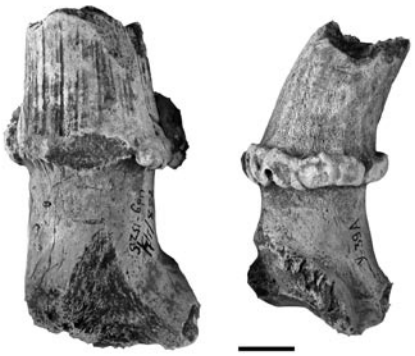

Figure 5b. Two antlers of *Axis* sp. Scale, 2 cm.

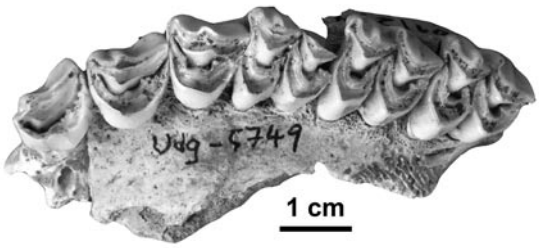

Figure 6. Occlusal view of a left maxilla preserving P^2-M^3 (Udg-5749) of *Capreolus constantini*. Scale, 1 cm.

Figure 8. Skull fragment with the base of antler (Udg-2442, dorsal view) of *Capreolus constantini*. Scale, 1 cm.

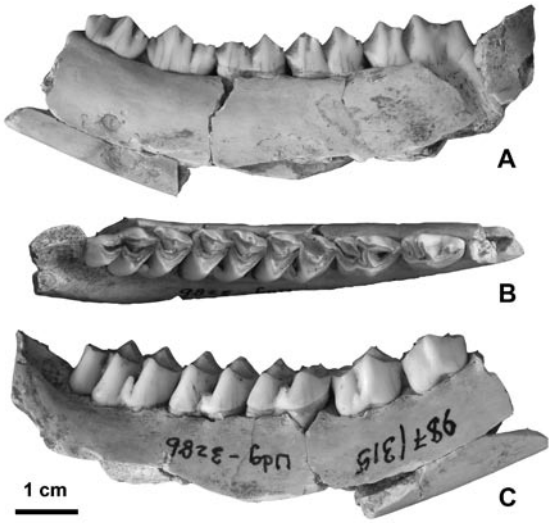

Figure 7. A right mandible preserving P_3-M_3 (Udg-3286) of *Capreolus constantini*: medial (**A**), occlusal (**B**), and lateral (**C**) views. Scale, 1 cm.

wide.

BOVIDAE

Antilopinae

Antilospira zdanskyi

Antilospira zdanskyi was established by Teilhard de Chardin and Trassaert (1938) based on the cranial fragment with two horn cores discovered from the upper Pliocene of southeast Shansi Province, northern China. It is a large antelope with weakly spiral horn cores. The specimens from Udunga are much smaller than other species of *Antilospira*, such as *A.*

Figure 9. Two horns of *Antilospira zdanskyi* (left, 983/75; right, 981/10). Scale, 2cm.

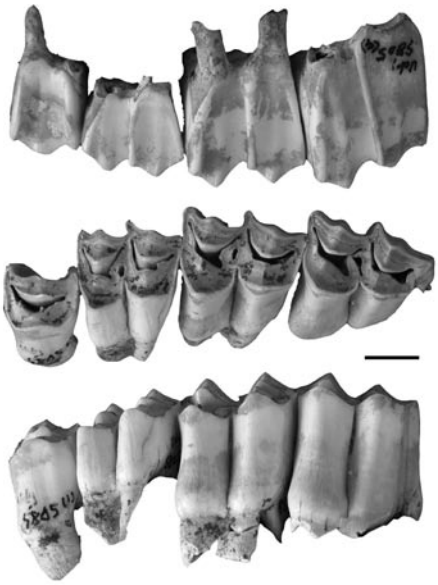

Figure 10. Left P^4-M^3 (Udg-5845) of *Gazella* sp. Buccal (top), occlusal (middle) and lingual (botom) views. Scale, 1 cm.

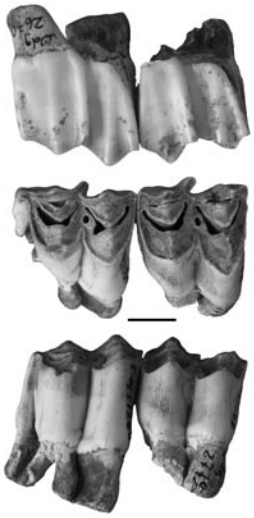

Figure 11. Right M^2 (Udg-2670) and M^3 (Udg-2779) of *Ovis* sp. Buccal (top), occlusal (middle) and lingual (botom) views. Scale, 1 cm.

licenti, A. gracilis, and *A. robusta* (Figure 4, Appendix 2), suggesting the possibility of a different species. Neither dentition nor postcranial specimens was reported in previous works, so it is hard to identify the postcranial/dental materials of *Antilospira zdanskyi*.

Gazella spp.

The result of the present work indicates that there are at least four types of *Gazella* included in the Udunga fauna (Table 3; Figure 2), and *Gasella* C probably corresponds to *G. sinensis*, which was established by Teilhard and Piveteau (1930) based on some cranialand dental specimens. Later, Dmitrieva (1977) proposed new subgenus, *Vetagazella*, to *Gazella sinensis* discovered from the late Pliocene of Shamar, Mongolia.

Caprinae

***Ovis* sp.**

Vislobokova et al. (1995) described some specimens of *Ovis* sp., including posterior part of skull, left horn and some isolated teeth, but their photo of the left horn (GIN 987/1079, figure 6D) is not of *Ovis* but probably of *Gazella*. Dental specimens referred to *Ovis* is not so much.

Statistic analysis of the hind limb bones

We chosed four hind limb bones in this analysis (astragalus, calcaneus, naviculocuboid, and distal tibia), because these postcranial bones are preserved in relatively good condition, and it is possible to get enough specimens for statistical analysis. Both right and left side

Table 4. Numbers of the postcranial specimens of Udunga artiodactyls used in this report.

	number of specimens	specimens used for PCA analysis
Astragalus	166	86
Nabiculocuboid	78	52
Tibia		
Bovidae	55	39
Cervidae	88	67
Capreolus	34	27
bovid or cervid	15	2
total	192	135
Calcaneus	46	20

Table 5. Abbreviations of the mesurements of hindlimb bones.

astragalus	
GLm	greatest length at the medial side
GLl	greatest length at the lateral side
Bfp	breadth of facet proximal
Bfd	breadth of facet distal
Mal	minimum astragalus length
distal tibia	
Btd	breadth of tibia at the distal end
Bias	breadth of inferior articular surface of tibia
Dtl	depth of tibia at the lateral side
Dtm	depth of tibia at the medial side
calcaneus	
Cx1	height of articular surface for cuboid
Cx2	height of talar articular surface
Cx3	height of sustentaculum tali
SDct	smallest depth of calcaneal tuberosity
H3c	distal part of calcaneus to proximal part of posterior talar articular surface
naviculocuboid	
Dnc	depth of naviculocuboid
B1nc	breadth of naviculocuboid
B2nc	breadth of superior articular surface
Hnc	height of naviculocuboid
Xnc	depth of inferior articular surface (articulated forth and fifth metatarsal)

of bones were used for the analysis, because it is hard to confirm whether right and left specimens are included into the same individual or not. All specimens were measured in mm using a digital caliper, and were analyzed by the statistic package PAST ver.1.29 (O. Hammer and D. A. T. Harper, 2005; http://folk.unio.no/ohammer/past/index.html). Although most of the specimens housed at the Southern Scientific Centre (SSC) retain the original field specimen number, such as 983/32, there are so many duplications of the number that we re-numbered Udg-series, such as Udg-02580, to all the specimens. Numbers of the postcranial specimens used in this analysis is indicated in Table 4, and the measurements we took in this analysis indicated in Appendix 2-6. A total of six, four, five, and five measurements were taken for analysis on the astragalus, distal tibia, calcaneus, and naviculocuboid, respectively.

Unfortunately, we did not measure dentitions, because the preparation and classification of such dental remains has not yet been completed. The detailed analysis including dental, antler, horn, and other postcranial materials of artiodactyls would be reported in the future.

Even though Vislobokoca et al. (1995) classified the Udunga artiodactyls into seven species, at least ten species of artiodactyls have so far been distinguished. Among the Bovidae, five species such as *Ovis* sp., four species of *Gazella*, and *Antilospira* are identified by using skull and horn morphology. At least four species of Cervidae such as *Capreolus* sp., small cervid, "*Alces*" sp., *Orchoceros*, and *Axis*, or large cervid are discriminated by its skull and antler morphology.

Because the taxonomy of an artiodactyl specimen is usually identified based on its horn

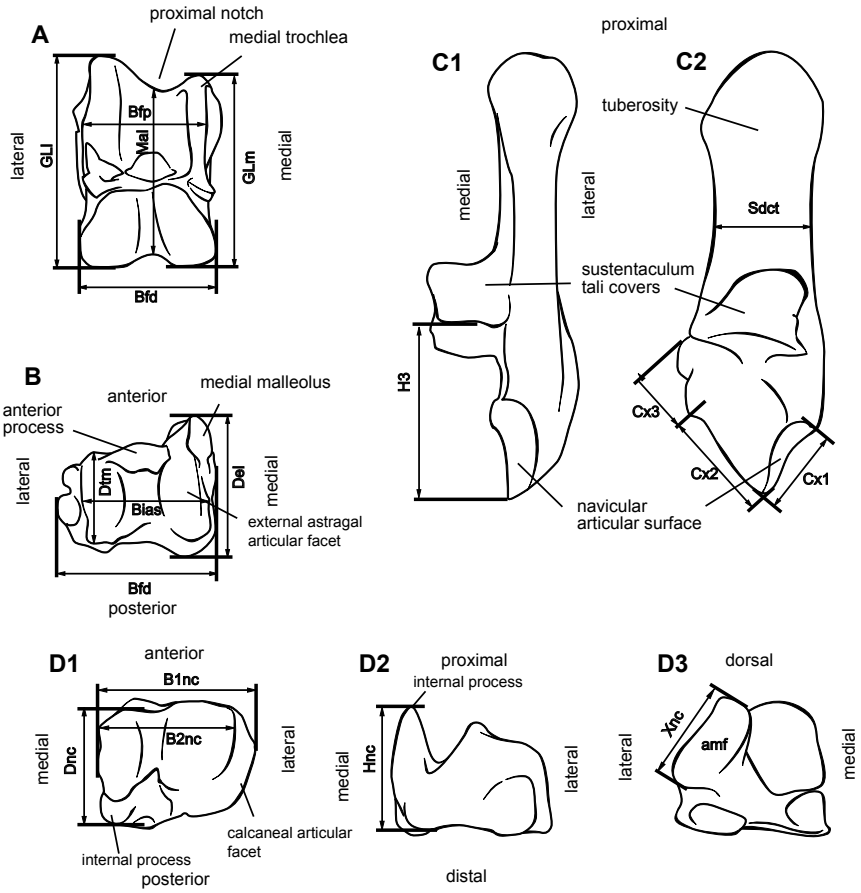

Figure 12. The way of measuring of the postcranial bones used in this study. **A**, dosal view of a left astragalus. **B**, distal view of right tibia. **C**, plantar (**C1**) and medial (**C2**) views of right calcaneus. **D**, proximal (**D1**), lateral (**D2**), and distal (**D3**) views of a naviculocuboid.

or antler morphology, taxonomic identification of isolated skeletal and dental materials are limited. However, for certain skeletal parts, we could identify their family level taxonomy based on the morphology. Among the more than 2000 specimens, nearly 350 of well-preserved isolated hind limb bones are collected by Kalmykov and his colleagues in the last two decades. In this article, we describe these artiodactyl hind limb bones.

Astragalus (Figure 13, Appendix 3)

Bovid specimens tend to have medio-laterally opened proximal notch and its lateral tibial trochlea is rolling. The postero-proximal part of medial trochlea is rounded on cervid astragalus. Principal component analyses (PCA) for three variables of measurements of astragalus (Appendix 3) are shown in Figure 13. Principal component (PC)I (96.19% of variance) represents all of three variables as the size elements. The large specimens tend to be fall in positive value and the small ones tend to be fall in the area of negative one. Cervid has relatively narrow breadth of distal facet (Bfd) and depth of astragalus at the medial side (Dam), then these specimens are plotted concentrate in the negative side on PC II (2.69% of variance). Characters plotted in the side of lorded positively on PC II have the broad

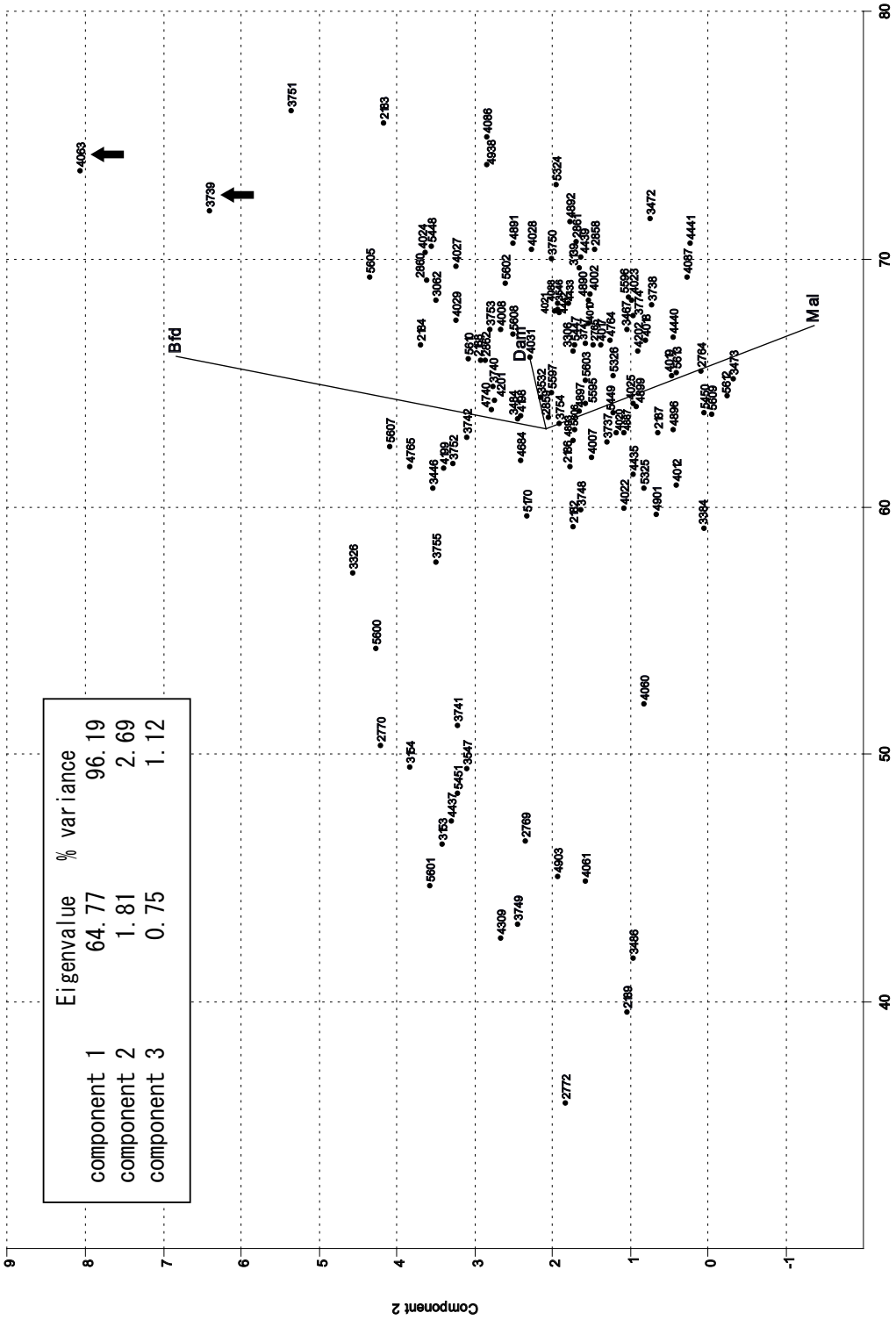

Figure 13. The result of the Principal Component Analysis (PCA) of astragalus. Black arros mean bovids and white arros mean cervids.

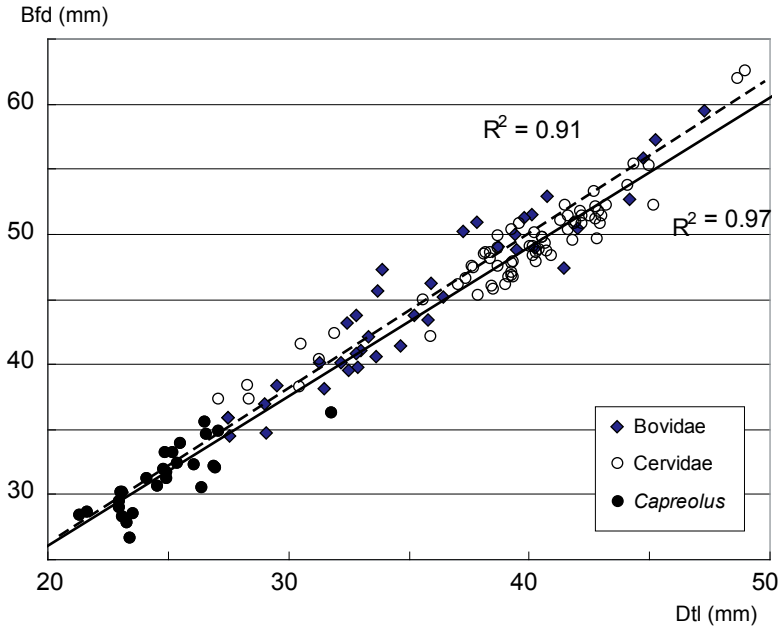

Figure 14. Scatterplots of the proportion of distal tibia. Dtl, depth of tibia at the lateral side; Bfd, bredth of tibia at the distal end.

Bfd. The specimens which have stout astragalus are tend to fall in the positive side in PC II such as large bovid (e.x. Udg-4063, 3739, indicated by black arros in Figure 13). However, *Gazella,* which has relatively slender body and has low Bfd score, is considered to be plotted mainly in the lower part of the PC II.

Plummer et al. (2008) attempted to reconstruct the habitat of living bovid using discriminant function analysis using the measurements of astragalus. According to their study, the measurements of the minimum astragalus length, depth of medial portion of tarsal articulation, and tarsal articulation M-L (medio-lateral) gratefully affect to distinguish the forest and open habitats. Plummer et al. (2008) concluded that the minimum astragalus length and depth of medial portion of tarsal articulation reflect the open habitat, and tarsal articulation M-L reflects the forest habitat. These measurements are correspondent to the minimum astragalus length (Mal), Dam, and Btd on this study. Characters plotted in the side of lorded positively on PC II shows clear contrast between Bfd and Mal. This result may support the differences of open and forest habitat.

Distal tibia (Figure 14, Appendix 4)

Generally, bovids have the dorsal-plantarly broad external astragal articuler facet and its medial malleolus is straight. Cervids have the acute anterior process on lateral surface. The medial malleolus of cervids is higher than that of bovids. Cervids also have the narrow external astragal articuler facet.

Cervids have prominent tibial tuberosity, and the depth of tibia at the lateral side (Dtl) is larger than that of bovids. Figure 14 shows the measurements of Dtl and breadth of tibia at the distal end (Btd) in 134 specimens. No clear differences were seen between bovid and

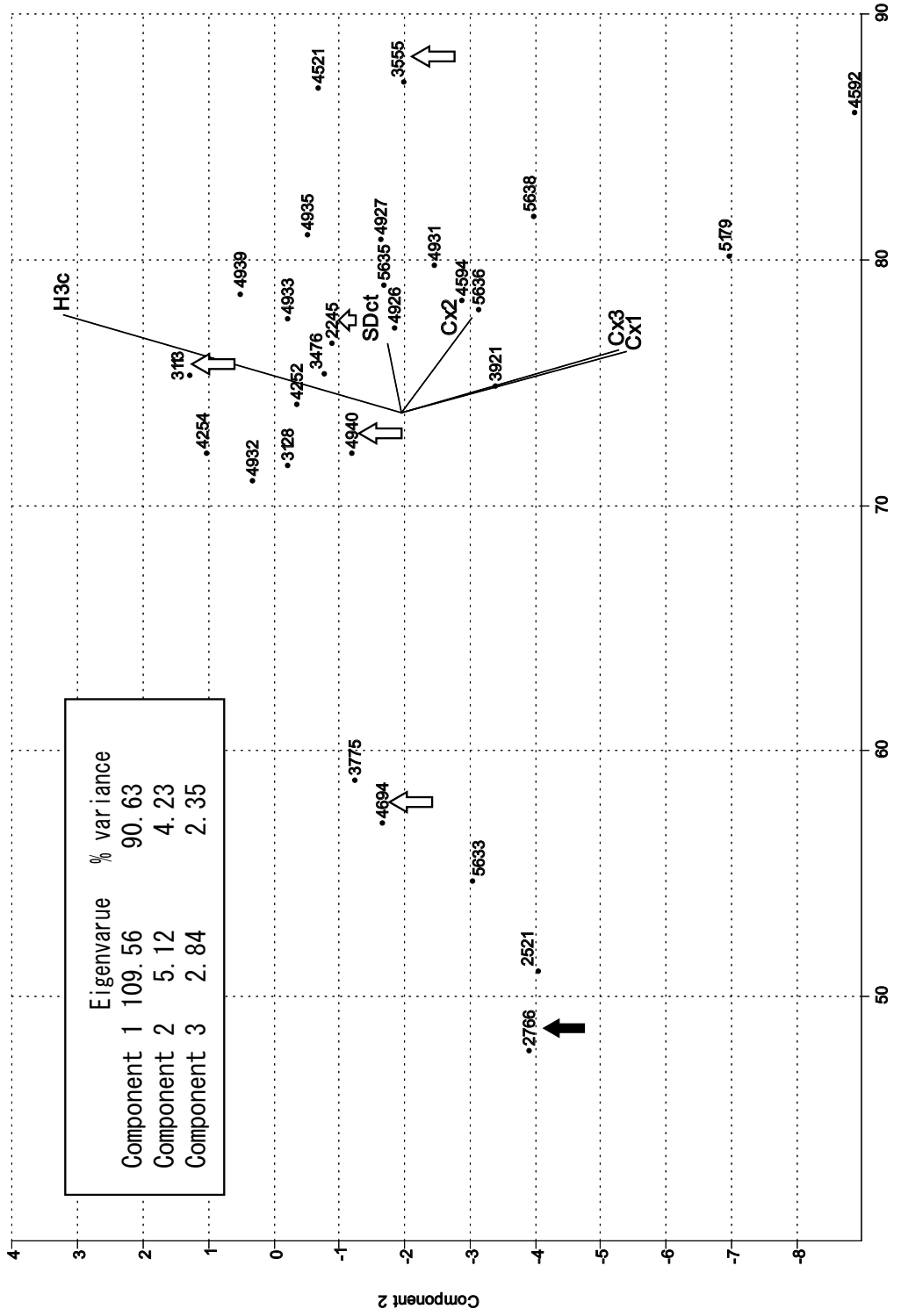

Figure 15. The result of the Principal Compornent Analysis of the calcaneus. Black arros mean bovids and white arros mean cervids.

cervid, but only *Capreolus* is clearly distinguished from other large artiodactyls. Cervids have a large mass during 37-45 mm on Dtl and 45-55 mm on Btd, while bovids show rather uniform distribution from small to large size (Figure 14). Both regression lines of bovids and cervids show similar trends. Extremely large cervid (Udg-3307) is considered *Alces* sp. but this specimen is plotted above the regression line of bovid. This result was probably caused by the body characteristics of "*Alces*" sp., which has large and stout body as well as the large bovids.

Calcaneus (Figure 15, Appendix 5)

In small quantity of well preserved artiodactyl calcanea collected from the Udunga fauna, 28 specimens are used at the Principal component analyses (PCA).

The proximal part of the tuberosity of cervids calcaneus is narrower than that of bovids. The bovids calcaneus is parallel in the lateral view of tuberosity body. The navicular articuler surface of cervids calcaneus appears uncus-liked, whereas the surface is rather straight in bovids. Cervids also have thick proximal-distal width on sustentaculum astragali covers, which affects the thickness of distal part of calcaneus to proximal part of posterior astragali articular surface (H3c). In the result of PCA (Figure 15), cervid specimens stand out with relatively high value for H3c variable on PC II (4.23% of variance), which places them in the positive side. Judging from the characteristics of navicular articular surface, Udg-2245, 3113, 3555, and 4940 are considered as cervid (indicated by white arrows in Figure 15). These specimens, which mainly places upper right in figure 15, show a pronounced propensity to be identified as cervids.

Five specimens (Udg-3775, 4694, 5633, 2521, 2766) plotted in the negative side on PC I because of its small size (FIgure 15). Among them, only Udg-2766 has straight navicular articular surface,so is considered bovids. Udg-3774 and 4694 are considered *Capleorus* because of having uncus-like navicular articular surface. On the other hand, there are extremely large bovid and cervid specimens for each hind limb bones (Figure 15). In reference to the horn and antler study, these large specimens should be identified as *Bos* (Udg-4592) and "*Alces*" (Udg-3555 and 4521).

Naviculocuboid (Figure 16, Appendix 6)

In bovids naviculocuboids the lateral part of the internal process is broadly expanded and the notch between internal process-medial process is shallow. Cervids have the uncus-liked calcaneal articuler facet, while bovids have slightly straight one. In the principal component analyses (PCA) for four variables of measurements of naviculocuboid PC I (95.17% of variance) represents all of four variables as the size elements (Figure 16, Appendix 6). The larger specimens tend to fall in the positive value, while the smaller ones tend to fall in the area of negative side. The negative loadings on PC II (2.69% of variance), both the depth of naviculocuboid (Dnc) and height of naviculocuboid (Hnc) show the great contribution. The

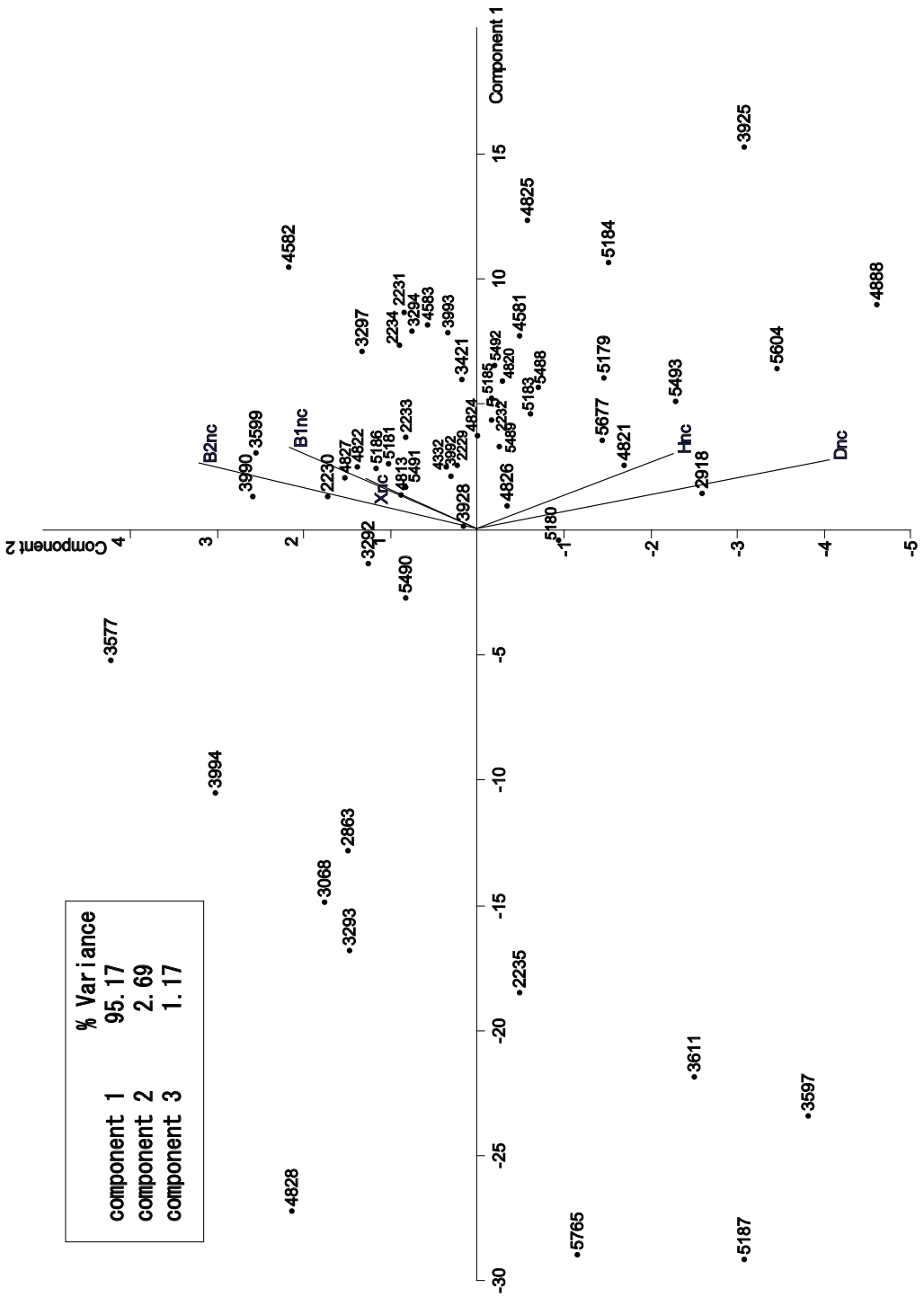

Figure 16. The result of the Principal Component Analysis of the naviculocuboid.

specimens, which have high and stout characteristics tend to fall in the negative side of PC II axis. On the other hand, medio-distally broad specimens are plotted in the positive side. The smaller specimens, such as *Capreolus* and small bovids, tend to fall in the negative value on PC I.

Discussion

The Udunga artiodactyls of the SSC collection were classified into at least ten taxa by the morphology of horns and antlers.

The four parts of hind limb bones of the Udunga artiodactyls were studied using statistical analyses. The results show that the cervid specimens are more abundant than that of the bovid ones in the Udunga fauna, corresponding to the results of morphological analysis of the horn/antler specimens.

Several species of small artiodactyls are likely included in the fauna, but it could not be differenciated by using any statistical analyses (Figures 13-16). Most of the small artiodactyl specimens are considered *Capreolus,* but there could be several specimens of another small cervids regarded by the antler morphology. However, it is hard to identify the taxonomic name in this study.

There are about six species of middle-sized artiodactyls included in the Udunga fauna, but it is difficult to distinguish them from each other. Especially, it is impossible to distinguish four forms of *Gazella* only by the statistical analyses of the postcranial bones.

Although several specimens of large sized artiodactyls are identified by the morphological characteristics, the statistical analyses of the postcranial bones are not useful for identifying these specimens. However, the morphological characteristics are more notably seen in large sized artiodactyls than in that of middle or small sized ones. The large sized artiodactyls of the Udunga fauna could be identified by the postcranial morphology.

On the result of the PCA of hind limb bones, PC I represents all variables as the size elements. Bovids have a tendency to have broad and stout morphology, but several small bovid specimens, such as *Gazella,* seem to have much slender shape as do cervids. This assumption makes it difficult to identify the taxa using PCA. There are several saturation spots of specimens in Figures 13, 15, and 16 (e. g. the fourth quadrant of Figure 13 and the first quadrant of Figure 16). These spots are considered as the group of same species.

The morphological differences between bovids and cervids also appear in the breadth and depth on hind limb bones, though there is a possibility of the false recognition due to the sexual dimorphism and/or the different growth stages. The artiodactyl species should be identified by the morphology of the horns and antlers, but the statistical analyses of hind limb bones could be useful for the support of the classification.

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Appendix 1. Measurements (mm) of the antler specimens used in this report. DAPb, diameter of the antler just above the burr; DAPr, antero-posterior diameter of burr; DAPp, diameter of the antler just beneath the burr; L, length; H2, height of bifurcation. Abbreviations are from van der Made and Tong (2008).

No.	taxon	DAPb	DAPr	DAPp	L	H2	remarks	minimal
Udg-1588	*Capreolus*			26.0	19.5			
Udg-1590	*Capreolus*	23.0	43.0		17.0			
Udg-1582	*Capreolus*	35.0	39.0 (?)	37.5	10.5			
Udg-1586	*Capreolus*	21.0	32.0	20.0	16.0			
Udg-1580	*Capreolus*	28.5	34.0	27.0	19.0?			
Udg-1576	*Capreolus*	28.0	34.5	25.0	23.5			
Udg-1523	*Capreolus*	24.0	35.0	25.5	16.0			
Udg-1585	*Capreolus*			27.0	13.0			
Udg-1577	*Capreolus*	20.5	28.0	20.0	18.5			
Udg-1572	*Capreolus*	28.5	42.0	22.0	15.0			
Udg-1576	*Capreolus*	27.0	39.0	24.5	12.0			
Udg-1584	*Capreolus*			25.0	15.0			
Udg-1574	*Capreolus*	22.5	30.0	20.5	16.0			
01/211	*Capreolus*	25.0		24.0	19.0			
02/189	*Capreolus*			27.5	14.5			
02/59	*Capreolus*	30.0		30.0	16.0			
Udg-1473	*Capreolus*	24.0		24.0	13.0			
Udg-1481	*Capreolus*			26.5	10.0		old individual with L & R frontal fused	
Udg-1471	*Capreolus*	31.0	47.0	35.0	13.0			
Udg-1472	*Capreolus*	26.5	35.3	24.0				
Udg-1478	*Capreolus*	24.5	34.5					
Udg-1474	*Capreolus*	24.0	35.0	23.0				
Udg-1241	*Capreolus*			20.0				
Udg-1238	*Capreolus*	30.5	41.0	26.5				
Udg-1227	*Capreolus*	26.0	34.0	20.5	22.5			
Udg-1231	*Capreolus*	33.0	46.0	31.0	12.5			
Udg-1233	*Capreolus*	33.0	44.0	34.0				
Udg-1236	*Capreolus*	28.0	38.0	25.0				
Udg-1235	*Capreolus*	32.0	45.5					
Udg-1234	*Capreolus*	27.4	35.5	23.0	10.0			
Udg-1226	*Capreolus*			31.0				
Udg-1230	*Capreolus*	23.0		22.5				
Udg-1232	*Capreolus*			21.0	10.0			
Udg-1452	*Capreolus*	28.0		24.5	15.0			
Udg-1461	*Capreolus*	27.0	36.0?					
Udg-1458	*Capreolus*	35.0	48.0	31.0	12.0			
Udg-2501	*Capreolus*	29.5	47.5	28.0	15.0			
Udg-2502	*Capreolus*	30.0	37.5		10.0			
Udg-2318	*Capreolus*	29.5	37.0?	26.0	12.0			
Udg-2829	*Capreolus*	21.0	29.5	21.0	9.5			
Udg-2320	*Capreolus*	18.5	42.5		17.0			
Udg-2328	*Capreolus*	24.0	39.0	22.5				
Udg-2330	*Capreolus*			30.5	18.5			
Udg-1060	*Capreolus*	27.5		26.5				
Udg-1066	*Capreolus*	29.0	38.5	27.5				
Udg-1056	*Capreolus*	34.0	43.0	29.5	13.5			
Udg-1070	*Capreolus*	27.0	34.0	25.0	10.5			
Udg-1061	*Capreolus*	27.0	38.0					
Udg-1065	*Capreolus*	29.0	37.0	28.0				
Udg-1067	*Capreolus*	23.0	30.0					
01/02	*Capreolus*	39.0	49.5	32.5	16.5			
01/95	*Capreolus*	29.0	40.0	29.0	21.0			
01/05	*Capreolus*	38.0	50.0?	27.0	12.5			
01/25	*Capreolus*	16.0	26.0	19.0	14.0			
01/22	*Capreolus*	17.5	27.0	20.0	13.5			
01/94	*Capreolus*	26.5	37.0	22.0	20.0			
Udg-1071	*Capreolus*	26.5	39.0?	30.0	13.0			
Udg-2490	*Capreolus*	25.0		24.5	37.0			
Udg-2498	*Capreolus*	37.0		36.0	17.5?			
no number	*Capreolus*	35.0	52.0	30.0				
Udg-1064	*Capreolus*	27.0	35.5	23.5	15.0			
Udg-2497	*Capreolus*	32.0	40.5	26.7	19.5			
Udg-2493	*Capreolus*	26.0	32.8	25.0	16.4			
Udg-2492	*Capreolus*	24.5		25.5	17.5	143.0?		
01/82	*Capreolus*	18.0	16.0	20.0				
01/86	*Capreolus*	21.5	30.0	21.0	14.5			
01/66	*Capreolus*	17.0		19.0	16.0			
01/94	*Capreolus*	29.5	40.0	23.5				
01/325	*Capreolus*	33.5	45.0	28.0				
01/341	*Capreolus*	40.5	47.0	33.5	15.0			

Appendix 1. continued.

No.	taxon	DAPb	DAPr	DAPp	L	H2	remarks	minimal
Udg-2040	*Capreolus*	16.5	23.0	17.0	12.5	113.0	left antler	
Udg-2039	*Capreolus*	17.5	24.0	17.0	14.0	115.0	right antler	
Udg-1250	*Capreolus*	17.5	26.0	18.5	13.0			
Udg-1245	*Capreolus*	31.0	45.0	27.5	21.5			
Udg-1246	*Capreolus*	25.5	42.0	29.0				
Udg-1252	*Capreolus*	26.0		25.0	17.3			
Udg-1247	*Capreolus*	26.0		23.5	19.0			
no number	*Capreolus*	29.0	38.0	25.5				
990/505	*Capreolus*	26.5	39.0	22.0	9.5			
Udg-1692	*Capreolus*	22.0	29.5	19.8		145.0	left antler, including Udg-1694, 1699	
Udg-1693	*Capreolus*	21.0	32.0	20.5	14.0	126.0	left antler, including Udg-1698, 1695	
Udg-1691	*Capreolus*	25.5	35.5	22.5	13.0			
Udg-2443	*Capreolus*	31.0	48.0	25.5	14.0			
Udg-2449	*Capreolus*	29.5	43.3	23.5	12.5			
Udg-2442	*Capreolus*	27.5	41.0	23.5	11.5		old individual with frontals fused	
Udg-1425	*Capreolus*	34.0	44.0	29.5				
Udg-1442	*Capreolus*	23.0	36.0	23.0	16.0			
Udg-1450	*Capreolus*		36.0	25.0				
Udg-1429	*Capreolus*		34.5	20.0				
Udg-1436	*Capreolus*			24.0	13.5			
Udg-1441	*Capreolus*	34.5	43.0	30.5	16.0			
Udg-2049	*Capreolus*	24.0	32.0?	24.0	21.0			
Udg-2048	*Capreolus*	21.5	28.5	20.0	15.0			
Udg-2045	*Capreolus*	32.0	41.5	25.3	15.5			
Udg-2042	*Capreolus*	29.5	39.5	24.0	23.2	150.5		
Udg-2041	*Capreolus*	32.0		32.0	16.0	149.0		
Udg-2044	*Capreolus*	32.0		31.0	17.0?	157.0		
Udg-2128	*Capreolus*	21.5	32.5	22.0	17.5			
Udg-2129	*Capreolus*	27.0		23.0	18.0			
Udg-2126	*Capreolus*	24.5	32.5	23.0	20.0			
Udg-1626	*Capreolus*	31.0	38.3		13.0			
Udg-1633	*Capreolus*	38.2	35.0	26.3	12.0			
Udg-1618	*Capreolus*	28.3	40.5	28.5	15.3			
Udg-1630	*Capreolus*	32.3	46.5	25.0				
Udg-1634	*Capreolus*	31.7		26.7	14.0			
Udg-1631	*Capreolus*	27.0		26.5	13.2			
Udg-1418	*Capreolus*	27.2		24.0	14.5			
Udg-1421	*Capreolus*	29.0	35.0	23.5	19.0			
Udg-1423	*Capreolus*	27.0	37.0	23.0	13.2			
Udg-1424	*Capreolus*	30.0	39.5		18.0			
Udg-1419	*Capreolus*	30.4	40.5	26.0	12.5			
Udg-1917	*Capreolus*	32.0		32.0	16.0			
Udg-2217	*Capreolus*	27.0	35.5	23.5	19.5			
Udg-1714	*Capreolus*			25.0	16.0			
Udg-1408	*Capreolus*	26.0	37.2	25.5				
Udg-1399	*Capreolus*	35.0	46.0?	30.5	10.0			
Udg-1412	*Capreolus*	32.0		26.5	15.5			
Udg-1402	*Capreolus*	29.5	42.0	24.5	15.0			
Udg-1397	*Capreolus*	38.0	52.5		14.5			
Udg-1415	*Capreolus*	31.0		27.0	10.0			
Udg-1396	*Capreolus*	28.0	41.2	25.0				
Udg-1407	*Capreolus*	22.0	35.0	23.0	17.8			
Udg-1587	small cervid	34.0	35.0	29.0	45.0		not Capreolus	
Udg-0403	small cervid			31.0	42.0		not Capreolus	
Udg-1482	small cervid			37.2	33.0		not Capreolus	
Udg-2495	small cervid			29.0	47.0		not Capreolus	
Udg-1448	small cervid	33.5		33.8	21.0		not Capreolus	
Udg-1420	small cervid	26.8	35.5	23.0	15.5		not Capreolus	
Udg-1577	*Alces*	52.0	65.5					
Udg-2449	*Alces*	56.5	78.0					
01/52	*Alces*	56.0				154.0		57.0
01/62	*Alces*	50.0	73.5			160.0		50.0
Udg-1565	*Alces*	49.5	63.0					
Udg-1209	*Alces*	46.0	59.0			128.0		41.5
Udg-1640	*Alces*	56.0	64.0			135.0		
Udg-1650	*Alces*	48.5	59.0					
Udg-1651	*Alces*	45.5	61.0					
Udg-1649	*Alces*	46.5						
Udg-1653	*Alces*	49.0	64.0					
Udg-1655	*Alces*	54.5						

Appendix 1. continued.

No.	taxon	DAPb	DAPr	DAPp	L	H2	remarks	minimal
Udg-1342	*Alces*	50.0	67.0				perhaps Alces	
Udg-1085	*Alces*	44.0	60.0				perhaps Alces	43.0
Udg-1086	*Alces*	63.5	68.5				perhaps Alces	
Udg-1091	*Alces*	60.0	61.5	46.0	26.0		perhaps Alces, right	
Udg-0199	*Alces*						perhaps Alces	
Udg-1384	*Alces*	40.5					perhaps Alces	40.0
Udg-1668	*Alces*			31.5	62.0		perhaps Alces	
Udg-1639	*Alces*	34.0	44.0				perhaps Alces but too small	29.5
Udg-2125	*Axis*	30.0	38.0	24.5	16.0		perhaps Axis, left	
Udg-1525	*Axis/Orchonoceros*			48.5	23.0			
Udg-1522	*Axis/Orchonoceros*	58.5	69.0					
Udg-1517	*Axis/Orchonoceros*	47.0	58.0					
Udg-1519	*Axis/Orchonoceros*	45.5	62.0					42.0
Udg-1514	*Axis/Orchonoceros*	47.5	63.0					
Udg-1523	*Axis/Orchonoceros*			48.0			left	
Udg-1515	*Axis/Orchonoceros*	40.5	61.5					
Udg-1516	*Axis/Orchonoceros*	45.0	59.9					
Udg-1520	*Axis/Orchonoceros*	43.5						
no number	*Axis/Orchonoceros*			36.0	42.0		left	
no number	*Axis/Orchonoceros*	37.5	48.0					
Udg-1379	*Axis/Orchonoceros*	40.0	40.5					
Udg-1380	*Axis/Orchonoceros*	43.5						40.5
Udg-1374	*Axis/Orchonoceros*	39.9	49.5					36.0
Udg-1378	*Axis/Orchonoceros*	45.0						41.0
Udg-1377	*Axis/Orchonoceros*			46.0	32.0			
Udg-1373	*Axis/Orchonoceros*	49.5	64.5					48.0
Udg-1372	*Axis/Orchonoceros*	47.0						45.5
Udg-1368	*Axis/Orchonoceros*	47.7	62.5					
Udg-1369	*Axis/Orchonoceros*	43.6	54.0					
Udg-1370	*Axis/Orchonoceros*	48.0						42.5
Udg-1700	*Axis/Orchonoceros*	47.7	59.0					45.0
Udg-1367	*Axis/Orchonoceros*	43.0	55.5	38.5	24.5		left	
Udg-1365	*Axis/Orchonoceros*	45.5	65.0					
Udg-1353	*Axis/Orchonoceros*			50.5				
Udg-1354	*Axis/Orchonoceros*	39.0	52.0	41.0	23.0			
Udg-1364	*Axis/Orchonoceros*	52.5	67.3					
Udg-1368	*Axis/Orchonoceros*	45.5	54.0					
Udg-1356	*Axis/Orchonoceros*	51.3	64.0					
Udg-1360	*Axis/Orchonoceros*	42.0						36.5
Udg-1357	*Axis/Orchonoceros*	48.0	60.5					
Udg-2145	*Axis/Orchonoceros*		51.5	38.0	23.0		left	
Udg-2152	*Axis/Orchonoceros*	49.5	59.0					
Udg-2144	*Axis/Orchonoceros*			31.5	42.5		right	
Udg-2149	*Axis/Orchonoceros*	45.5	58.0					
Udg-2146	*Axis/Orchonoceros*	49.0	65.5					
Udg-2148	*Axis/Orchonoceros*	58.2						
Udg-2151	*Axis/Orchonoceros*			35.0	30.0			
Udg-1341	*Axis/Orchonoceros*	54.0	68.0	46.5	34.0		right	
Udg-1346	*Axis/Orchonoceros*		73.0	39.5	38.0		left	
Udg-1343	*Axis/Orchonoceros*	52.5						
Udg-1350	*Axis/Orchonoceros*	55.5	72.0					
Udg-1345	*Axis/Orchonoceros*	59.0	74.0					
Udg-1377	*Axis/Orchonoceros*	43.0	57.0					
Udg-1111	*Axis/Orchonoceros*	51.0		46.0	29.0			
Udg-1107	*Axis/Orchonoceros*	42.0					left	
Udg-1109	*Axis/Orchonoceros*			51.5	27.5		left	
Udg-1083	*Axis/Orchonoceros*	46.0						43.0
Udg-1087	*Axis/Orchonoceros*	48.0	58.7					
Udg-1093	*Axis/Orchonoceros*	49.0						
Udg-1094	*Axis/Orchonoceros*	43.0						
Udg-1092	*Axis/Orchonoceros*	44.5	56.0					
Udg-1095	*Axis/Orchonoceros*	50.0	62.0					
Udg-1096	*Axis/Orchonoceros*	47.4	61.0					
Udg-1101	*Axis/Orchonoceros*			48.0	28.0		left	
Udg-1103	*Axis/Orchonoceros*			48.7	43.0		left	
Udg-1105	*Axis/Orchonoceros*			45.5			left	
Udg-1106	*Axis/Orchonoceros*			46.5	28.0			
01/331	*Axis/Orchonoceros*	46.0	47.5	52.5	21.0		left	
01/65	*Axis/Orchonoceros*	49.5	63.5					
01/53	*Axis/Orchonoceros*	47.0	64.0					43.0

Appendix 1. continued.

No.	taxon	DAPb	DAPr	DAPp	L	H2	remarks	minimal
01/53-2	*Axis/Orchonoceros*	41.0	58.0					
01/346	*Axis/Orchonoceros*	52.5	63.0					
01/87	*Axis/Orchonoceros*			43.0				
01/18	*Axis/Orchonoceros*		55.0	43.5	28.0			
01/96	*Axis/Orchonoceros*	36.5	45.5					
01/88	*Axis/Orchonoceros*	52.5	58.0	49.0				45.5
01/55	*Axis/Orchonoceros*	47.5	63.5					40.5
01/56	*Axis/Orchonoceros*	52.0	61.0					52.0
01/54	*Axis/Orchonoceros*	44.0	58.0					38.0
01/296	*Axis/Orchonoceros*			49.5	26.0		left	
01/19	*Axis/Orchonoceros*	44.5						43.0
01/20	*Axis/Orchonoceros*	40.0	51.5					37.0
01/03	*Axis/Orchonoceros*	47.5	54.0	41.0	32.0			
01/253	*Axis/Orchonoceros*	48.5	60.0					
01/328	*Axis/Orchonoceros*			50.0	48.0			
01/01	*Axis/Orchonoceros*			40.5	45.0			
01/67	*Axis/Orchonoceros*			39.0	23.0			
Udg-0199	*Axis/Orchonoceros*			32.5	53.0		skull fragment	
03/456	*Axis/Orchonoceros*	46.5	59.0					44.5
Udg-2253	*Axis/Orchonoceros*	42.0	54.0					
Udg-1385	*Axis/Orchonoceros*	43.5						39.0
Udg-0133	*Axis/Orchonoceros*	43.0	59.5					
Udg-1382	*Axis/Orchonoceros*	47.0	58.0					
no number	*Axis/Orchonoceros*			47.0	40.0		right	
no number	*Axis/Orchonoceros*	52.0	56.5	48.0	23.0		left	
01/345	*Axis/Orchonoceros*	61.5	73.0					
01/60	*Axis/Orchonoceros*	37.0	48.0					
01/73	*Axis/Orchonoceros*	52.0	61.1					
01/15	*Axis/Orchonoceros*	58.0	61.1					
01/75	*Axis/Orchonoceros*	54.0	65.0					
Udg-1368	*Axis/Orchonoceros*			41.0	29.0		right	
Udg-1535	*Axis/Orchonoceros*	61.5	80.0				biggest	
Udg-1539	*Axis/Orchonoceros*	57.0						
Udg-1540	*Axis/Orchonoceros*	47.0	64.0					
Udg-1527	*Axis/Orchonoceros*			48.5	56.0		left	
Udg-1530	*Axis/Orchonoceros*	51.0	60.0					
Udg-1534	*Axis/Orchonoceros*	60.5	76.0					
Udg-1533	*Axis/Orchonoceros*			52.0	41.0		right	
Udg-1529	*Axis/Orchonoceros*	52.0	60.0					
Udg-1526	*Axis/Orchonoceros*	49.0	67.0	45.5				
985/215-c	*Axis/Orchonoceros*			47.5	31.0		left	
Udg-1680	*Axis/Orchonoceros*	44.5	52.0					
Udg-1664	*Axis/Orchonoceros*			34.0	35.5			
Udg-1659	*Axis/Orchonoceros*		59.0	46.7	26.0			
Udg-2153	*Axis/Orchonoceros*	47.0	64.0	44.0	25.0			
Udg-2157	*Axis/Orchonoceros*	47.0	57.0	36.0	23.0			
Udg-2158	*Axis/Orchonoceros*	53.0	72.5					
Udg-2155	*Axis/Orchonoceros*	41.0	53.0	36.0	35.5		left	
Udg-2156	*Axis/Orchonoceros*			42.0	46.0		right	
Udg-2154	*Axis/Orchonoceros*	45.5	59.0					
Udg-1613	*Axis/Orchonoceros*	46.5	52.0	38.0	33.5			
Udg-1610	*Axis/Orchonoceros*			44.5	42.5			
Udg-1614	*Axis/Orchonoceros*			37.0	36.0			
Udg-1609	*Axis/Orchonoceros*			48.5	35.5		right	
Udg-1612	*Axis/Orchonoceros*			41.5	35.0		left	
Udg-1611	*Axis/Orchonoceros*			53.0				
Udg-1613	*Axis/Orchonoceros*			42.5	33.5			
Udg-1607	*Axis/Orchonoceros*			41.0				
Udg-1595	*Axis/Orchonoceros*	57.0	60.5					
Udg-1112	*Axis/Orchonoceros*	53.0	60.0					
Udg-1598	*Axis/Orchonoceros*	49.0						
Udg-1594	*Axis/Orchonoceros*	51.0	61.5					
Udg-1112	*Axis/Orchonoceros*	49.0	67.5					46.8
Udg-1656	*Axis/Orchonoceros*	44.5	54.7					41.5
Udg-1637	*Axis/Orchonoceros*	40.0						
Udg-1648	*Axis/Orchonoceros*	40.5	57.0					
Udg-1652	*Axis/Orchonoceros*	42.0	50.5					
Udg-1215	*Axis/Orchonoceros*	49.5	64.5					
Udg-1214	*Axis/Orchonoceros*	44.5	63.0					43.5
Udg-1205	*Axis/Orchonoceros*	58.7						

Appendix 1. continued.

No.	taxon	DAPb	DAPr	DAPp	L	H2	remarks	minimal
Udg-1199	*Axis/Orchonoceros*	48.0	62.0					
Udg-1196	*Axis/Orchonoceros*	54.0	66.5					
Udg-1195	*Axis/Orchonoceros*	49.0	66.0					
Udg-1207	*Axis/Orchonoceros*	45.4	61.4					
Udg-1202	*Axis/Orchonoceros*	45.5	64.0					
Udg-1198	*Axis/Orchonoceros*	41.5	57.0					
Udg-1201	*Axis/Orchonoceros*	48.0	63.0					
Udg-2305	*Axis/Orchonoceros*	48.0	56.5	44.5	33.5			
Udg-2306	*Axis/Orchonoceros*	44.5	62.8					
Udg-2309	*Axis/Orchonoceros*	51.0						
Udg-2302	*Axis/Orchonoceros*						right	
Udg-2301	*Axis/Orchonoceros*			49.5	45.5			
no number	*Axis/Orchonoceros*			43.5	25.0			
Udg-2516	*Axis/Orchonoceros*	53.0	62.0					
Udg-2120	*Axis/Orchonoceros*	42.0	53.5					
Udg-2125	*Axis/Orchonoceros*	54.0	67.0					
Udg-2112	*Axis/Orchonoceros*	44.0	62.0					
Udg-2121	*Axis/Orchonoceros*	49.5	61.5					
Udg-2118	*Axis/Orchonoceros*	51.0	69.0					
Udg-2119	*Axis/Orchonoceros*	40.5	54.0					
Udg-2113	*Axis/Orchonoceros*	45.0		41.0	23.5			
999/413	*Axis/Orchonoceros*	40.5	61.0					
01/39	*Axis/Orchonoceros*	40.5	46.0					
Udg-1643	*Axis/Orchonoceros*	44.0		42.5	31.0		right	
Udg-1110	*Axis/Orchonoceros*	40.5	49.5	35.0	23.0			
22.726	*A. shansius*	43.0					larger foem Teilhard & Trassaert (1937)	
14.333	*A. shansius*	35.0					larger foem Teilhard & Trassaert (1937)	
14.285	*A. shansius*	40.0					larger foem Teilhard & Trassaert (1937)	
10.518	*A. shansius*	40.0					larger foem Teilhard & Trassaert (1937)	
10.270	*A. shansius*	45.0					larger foem Teilhard & Trassaert (1937)	
10.798	*A. shansius*	44.0					larger foem Teilhard & Trassaert (1937)	
12.387	*A. shansius*	33.0					smaller form Teilhard & Trassaert (1937)	
10.213	*A. shansius*	35.0					smaller form Teilhard & Trassaert (1937)	
10.520	*A. shansius*	26.0					smaller form Teilhard & Trassaert (1937)	

Appendix 2. Measurements (mm) of the horn specimens used in this report. L, length; B, breadth.

No.	Taxa	L	B	remarks
Udg-0050	*Ovis* sp.	61.5	41.5	
Udg-0050	*Ovis* sp.	47.0	33.5	fragment
01/38	*Ovis* sp.	44.5	38.5	
no number	*Ovis* sp.	37.0	25.5	
Udg-2198	*Ovis* sp.	32.0	28.0	subadult
Udg-2268	*Gazella* A	35.0	26.0	
Udg-2269	*Gazella* A	36.0		restored
Udg-1277	*Gazella* B		50.0	restored, large form
y-00-002	*Gazella* C	32.0	30.0	curved horn
y-00-021	*Gazella* C	31.0	27.0	curved horn
no number	*Gazella* C	36.5	33.0	curved horn
990/65	*Gazella* C	32.5	28.5	curved horn
Udg-1199	*Gazella* C	33.0	28.0	curved horn
Udg-1176	*Gazella* C	30.0	25.0	curved horn
Udg-1178	*Gazella* C	27.5	24.0	curved horn
Udg-1177	*Gazella* C	28.0	24.0	curved horn
Udg-2498	*Gazella* C	34.0	27.0	curved horn
Udg-2497	*Gazella* C	33.5	27.5	curved horn
Udg-2499	*Gazella* C	31.5	24.5	curved horn
Udg-2563	*Gazella* C	29.5	23.5	curved horn
Udg-2562	*Gazella* C	31.2	25.0	curved horn
Udg-2561	*Gazella* C	31.5	23.5	curved horn
Udg-2560	*Gazella* C	30.0	24.4	curved horn
Udg-2564	*Gazella* C	31.5	26.5	curved horn
Udg-1038	*Gazella* C	33.2	27.0	curved horn
Udg-1041	*Gazella* C	41.4	34.0	curved horn
Udg-1037	*Gazella* C	35.5	29.0	curved horn
Udg-1035	*Gazella* C	32.0	27.5	curved horn
Udg-1040	*Gazella* C	30.0	25.0	curved horn
Udg-1039	*Gazella* C	35.0	28.5	curved horn
Udg-1034	*Gazella* C	32.5	27.0	curved horn
Udg-1036	*Gazella* C	36.5	28.0	curved horn
Udg-1033	*Gazella* C	31.0	27.5	curved horn
Udg-1704	*Gazella* C	40.5	34.5	curved horn
Udg-1702	*Gazella* C	29.5	23.0	curved horn
Udg-1705	*Gazella* C	35.0	27.3	curved horn
99/229	*Gazella* C	37.5		curved horn
Udg-2036	*Gazella* C	32.5	29.0	curved horn
Udg-1271	*Gazella* C	31.5	25.0	curved horn
Udg-1272	*Gazella* C	34.0	39.5	curved horn
01/335	*Gazella* C	38.0	32.0	curved horn
Udg-1274	*Gazella* C	38.5	32.0	curved horn
Udg-1273	*Gazella* C	33.5	29.0	curved horn
Udg-1048	*Gazella* C	38.0		curved horn
Udg-1334	*Gazella* D	48.5	50.5	straight horn
Udg-1335	*Gazella* D	51.5	52.0	straight horn
Udg-1338	*Gazella* D	60.0	60.0	straight horn
Udg-1337	*Gazella* D	52.0	51.0	straight horn
Udg-1645	*Gazella* D	37.0	33.0	subadult/calf, straight horn
Udg-1042	*Gazella* D	27.5	28.0	calf, straight horn
Udg-1192	*Gazella* D	55.0	53.5	straight horn
Udg-1053	*Gazella* D	57.5	56.5	straight horn
Udg-1054	*Gazella* D	48.0	50.0	straight horn
Udg-1049	*Gazella* D	47.0	48.0	straight horn
Udg-1713	*Antilospira*	41.5	32.0	
986/10	*Antilospira*	38.5	36.0	
Udg-0198	*Antilospira*	42.0	39.0	
Udg-0196	*Antilospira*	41.0	34.0	
Udg-0197	*Antilospira*	41.0	37.0	
Udg-1175	*Antilospira*	41.0	34.0	
Udg-2216	*Antilospira*	43.0	38.0	
Udg-0193B	*Antilospira*	45.5	40.0	
Udg-0193A	*Antilospira*	48.0	41.0	
*30.751	*G. sinensis*	26.0	22.0	
*30.797	*G. sinensis*	22.0	20.0	
*30.752	*G. sinensis*	25.0	20.0	
*10.492	*G. sinensis*			
*10.319	*G. sinensis*	28.0	22.0	
*18.913	*G. sinensis*	28.0	22.0	
*10.574	*G. sinensis*	25.0	21.0	
*22.921	*G. sinensis*	27.0	21.0	
*19.037	*G. sinensis*	28.0	24.0	
*22.352	*G. sinensis*			
*22.712	*G. sinensis*	35.0	29.0	
*22.887	*G. sinensis*	31.0	25.0	
*22.885	*G. sinensis*	31.0	30.0	
*22.712	*G. sinensis*	34.0	29.0	
*10.229	*G. sinensis*	28.0	22.0	
*10.408	*G. sinensis*	27.0	20.0	
*22.711	*G. sinensis*	27.0	19.0	
*10.560	*G. sinensis*			
*10.410	*G. sinensis*	27.0	24.0	
*Nihowan	*G. sinensis*	27.0	22.0	
*10.728	*G. sinensis*	38.0	31.0	
*21.026	*A. zdanskyi*	60.0	45.0	
*14.308	*A. robusta*	61.0	46.0	
*22.789	*A. robusta*	64.0	48.0	
*16.136	*A. robusta*	61.0	41.0	
*19.754	*A. robusta*	63.0	47.0	
*10.411	*A. gracilis*	39.0	29.0	
*10.378	*A. licenti*	41.0	32.0	
*10.375	*A. licenti*	37.0	30.5	
*10.429	*A. licenti*	40.0	33.0	
*10.349	*A. licenti*	36.0	31.0	
*10.377	*A. licenti*	35.0	29.0	

Appendix 3. Mesurements of the astragalus specimens of Udunga artiodactyls used in this report.

Udg-	side	Bfd	Bfp	Mal	Dm	GLl	GLm	taxon
3751	R	42.39	40.63	51.44	36.97	66.08	60.09	
4086	R	39.13	39.92	51.30	38.27	64.17	59.92	
4063	R	43.01	41.06	47.68	36.89	59.93	55.37	
5324	R	37.80	37.83	50.87	36.40	61.81	58.64	
2858	R	35.64	35.30	48.75	36.23	61.66	56.35	
3750	R	36.44	37.41	48.81	34.70	61.11	56.69	
3484	R	33.91	33.21	44.32	30.56	54.88	51.10	
4088	R	35.29	34.97	47.32	34.25	58.83	55.13	
2861	R	36.08	35.49	48.94	36.13	59.73	57.58	
4008	R	35.76	36.81	46.62	32.70	56.94	54.60	
5447	R	34.14	35.15	46.10	33.72	58.16	53.23	
3472	R	35.79	35.36	50.19	36.49	61.08	56.98	
4433	R	35.17	36.60	47.41	34.28	58.68	54.42	
4199	R	33.29	32.57	41.88	30.72	53.60	49.26	
2765	R	33.77	33.56	46.01	34.26	55.76	54.78	
3753	R	35.60	35.46	46.23	33.45	58.17	54.35	
4198	R	33.69	32.89	44.13	31.27	55.00	51.07	
3752	R	33.07	33.78	41.82	31.33	53.03	48.84	
4765	R	33.90	34.64	41.94	30.06	54.01	49.03	
2862	R	35.01	33.78	45.27	32.91	55.46	53.07	
5596	R	34.62	34.87	47.97	34.49	58.96	55.78	
5448	R	38.11	37.40	48.45	34.46	59.83	57.02	
2764	R	32.86	34.72	46.96	31.77	57.71	54.27	
2186	R	32.49	32.80	43.45	29.33	53.82	51.84	
4435	R	31.35	31.41	43.31	30.05	54.58	50.92	
3139	R	36.24	34.39	49.08	33.75	59.90	56.06	
4684	R	32.59	31.65	42.61	31.00	53.65	50.63	
5326	R	33.43	34.03	45.85	32.34	57.80	53.86	
3546	R	35.81	35.70	47.93	32.48	58.66	55.34	
4010	R	35.01	34.68	47.51	32.66	57.48	55.17	
3532	R	33.73	33.65	44.68	31.95	56.51	51.58	
5595	R	33.11	34.25	44.81	31.89	55.18	51.67	
5597	R	33.80	34.29	45.00	31.89	55.44	50.88	
5449	R	32.94	33.12	45.10	30.93	55.70	53.54	
4896	R	31.79	32.08	44.86	31.06	54.89	53.13	
4899	R	32.39	33.63	44.94	32.19	53.89	51.47	
3473	R	32.22	33.43	46.80	31.95	57.30	53.88	
4740	R	34.06	33.50	44.04	31.58	54.70	51.31	
5450	R	31.45	32.47	45.12	32.33	55.74	53.86	
3754	R	32.74	31.02	43.74	32.16	55.05	51.38	
2182	R	31.42	30.84	41.93	27.75	53.34	49.34	
3384	R	29.64	32.98	42.41	28.68	50.07	45.95	
5325	R	31.43	31.53	43.54	28.52	52.99	50.06	
2187	R	31.65	32.25	44.35	31.61	55.79	51.84	
4897	R	32.58	32.50	44.01	32.94	54.71	50.56	
4007	R	32.03	32.11	43.38	30.62	54.28	50.90	
4012	R	30.78	31.20	43.45	29.63	51.84	50.18	
4901	R	30.04	29.50	42.01	29.93	52.86	48.82	
3755	R	31.55	32.02	39.20	28.60	49.24	45.19	
5600	R	30.52	28.01	36.34	26.73	46.63	41.76	*Capreolus*
5451	R	27.36	26.79	33.49	22.23	40.36	37.42	*Capreolus*
5601	R	25.28	25.60	30.00	21.79	38.08	35.24	*Capreolus*
3153	R	26.00	26.94	31.31	22.56	38.48	36.35	
4437	R	26.18	25.96	31.82	23.44	40.02	36.20	*Capreolus*
3154	R	27.83	27.31	33.23	24.21	41.83	38.43	*Capreolus*
4903	R	24.36	25.86	31.52	21.30	38.14	36.21	*Capreolus*
4434	R	35.34	35.16	48.47	35.38		55.80	
3071	R	34.14	34.40	45.23	32.12		52.45	
4900	R	35.56		45.89	34.89		55.59	
4003	R	33.44	33.62	46.14		56.89	53.64	
4436	R	34.51	34.43		33.37	58.25	53.12	
4016	R	34.51		45.73	33.86	57.61		
4902	R	33.86		48.39	33.00	56.95	54.21	
5611	R	32.69	33.45	44.46	31.33		51.70	
5599	R	33.14	31.94	41.15	29.20		46.48	
5452	R	28.71	28.38				41.29	*Capreolus*
3615	R	28.16	28.11	34.12	25.09	42.13		*Capreolus*
3332	R		20.71	29.87	19.10	35.68		*Capreolus*
2183	L	41.03	39.76	51.59	37.11	64.22	60.18	
4938	L	39.57	37.87	51.70	35.06	62.26	59.41	
3739	L	41.07	38.27	47.73	35.47	61.72	55.87	
4891	L	37.38	37.00	49.22	34.37	59.88	56.87	
4028	L	36.99	35.46	49.10	34.49	60.90	57.65	
5608	L	35.58	34.40	46.63	32.51	58.53	54.22	
4439	L	36.09	34.65	48.97	34.87	61.37	56.12	
4890	L	35.20	35.39	47.85	33.82	58.84	55.33	
2859	L	33.12	33.68	43.99	31.95	55.58	51.30	
5605	L	37.62	34.34	46.50	35.21	58.52	53.82	
4023	L	34.58	35.04	47.96	34.31	59.25	56.02	
4024	L	38.40	36.00	48.64	33.43	60.11	56.17	
4442	L	35.55	36.33	47.64	32.79	59.17	55.18	
4021	L	35.31	36.61	47.27	33.77	58.86	54.94	
4892	L	36.65	37.14	49.60	36.28	59.55	57.52	

Udg-	side	Bfd	Bfp	Mal	Dm	GLl	GLm	taxon
3738	L	34.78	34.91	48.58	32.95	60.11	56.54	
2184	L	36.23	36.10	45.52	32.56	55.25	51.68	
3774	L	34.56	33.77	47.92	33.14	58.44	54.16	
4441	L	35.30	35.31	50.28	34.93	60.20	57.71	
5612	L	32.22	32.17	46.61	30.88	57.33	54.39	
4440	L	33.69	35.16	47.55	32.84	59.03	56.60	
4019	L	33.24	34.02	46.80	31.18	56.68	54.08	
2860	L	37.75	34.71	47.77	33.14	58.87	55.66	
4764	L	34.46	35.31	47.21	32.31	59.84	56.05	
5602	L	37.06	36.35	48.51	32.47	60.29	56.27	
4027	L	37.15	36.96	47.71	34.87	9.19	54.96	
4031	L	35.02	34.50	46.19	31.79	56.31	52.58	
4087	L	35.06	33.88	49.78	33.12	59.21	57.52	
4017	L	34.61	35.37	47.17	31.88	58.54	53.55	
2188	L	34.88	34.18	45.03	33.27	57.14	53.71	
3747	L	34.21	34.06	46.40	33.42	56.98	54.09	
4029	L	35.67	34.82	45.67	34.83	56.55	54.64	
5610	L	34.58	34.32	44.44	34.52	56.62	52.44	
3306	L	34.52	35.27	46.50	32.31	57.92	54.15	
5603	L	33.87	33.39	45.83	31.57	55.76	52.39	
4018	L	33.77	32.24	47.09	33.09	56.69	52.89	
3467	L	34.80	34.27	48.00	31.67	59.12	55.63	
5613	L	33.01	33.94	46.63	31.98	56.11	52.66	
4002	L	35.33	34.42	48.07	33.99	58.07	54.71	
3062	L	37.20	36.16	47.20	32.83	57.75	54.90	
3742	L	33.34	33.50	42.55	32.19	53.33	49.53	
4020	L	32.20	33.41	44.18	31.32	54.46	50.98	
4025	L	32.52	32.60	45.04	32.12	54.36	52.38	
4201	L	34.11	34.48	44.19	32.02	54.86	51.43	
3748	L	31.07	31.61	41.74	29.70	52.43	50.63	
5609	L	31.44	33.26	45.27	32.05	56.34	53.47	
5607	L	34.30	31.77	42.11	31.12	53.30	48.66	
4887	L	32.13	32.61	44.26	31.27	55.68	51.00	
3737	L	32.32	33.44	44.11	30.54	53.99	51.61	
3740	L	34.42	31.94	44.60	32.32	55.06	52.10	
4202	L	34.02	32.74	47.19	31.94	58.17	53.81	
4022	L	31.09	30.54	42.66	28.54	51.38	48.50	
4893	L	32.32	32.43	43.43	31.69	53.44	51.70	
5170	L	31.26	31.62	40.88	30.21	50.80	46.77	
3446	L	32.81	32.01	40.99	30.83	51.34	47.38	
3326	L	32.25	31.77	38.32	28.30	49.29	43.88	
4060	L	26.62	27.03	36.75	25.57	44.61	41.94	
3741	L	27.90	28.81	34.46	25.72	43.29	39.55	
4061	L	23.17	22.17	30.60	23.34	38.49	35.22	*Capreolus*
3547	L	27.24	27.68	33.64	24.05	41.68	37.49	
4309	L	23.36	23.25	28.89	20.94	36.02	33.43	*Capreolus*
2189	L	20.44	20.21	27.55	19.85	34.73	33.18	*Capreolus*
3749	L	23.42	22.87	29.34	21.35	36.27	34.06	*Capreolus*
2770	R	28.7	29.24	33.79	24.37	42.13	39.49	
2769	L	25.39	26.02	32.26	22.02	40.15	37.88	
3486	L	21.80	21.19	29.56	19.97	35.63	34.22	
2772	L	19.99	19.56	25.35	16.07	31.37	28.90	
5606	R	32.51	31.13	43.73	31.96	56.47	53.97	articulated
4200	L		40.51		35.93	66.22		
4059	L	42.25					58.94	
3743	L	36.90	36.23	49.47	33.64	60.26		
3746	L	35.18	35.30			56.52	54.29	
5453	L	35.10	33.62	46.75	31.76		55.45	
2857	L		35.68	47.32	34.39	58.67	54.22	
4030	L	35.67	34.30	48.20		57.87	54.54	
4011	L	36.39	36.59	48.80	34.31		56.38	
4026	L	35.37	35.38	48.67		61.03	55.77	
4899	L			46.97	31.08	56.68	53.12	
3745	L	31.42	32.19		30.55		49.96	
3329	L		31.34	40.42	28.21	49.04	46.16	
3315	L	26.23	27.48	33.33	25.50		38.77	
4062	L	28.03	28.10		24.50		39.12	
4766	L			25.40		31.43	29.42	*Capreolus*
4889	L	31.75						
5614	L							
2185	L	35.48		45.86	33.57		52.97	
3756	L				32.72		53.91	
2158	L		32.34					
4888	L	33.46	34.84		32.59	56.13	54.20	
5169	L	34.64	—		34.50	56.48		cervids
3835	L	31.34	30.24		27.47	49.35	46.33	cervids
3836	L	37.73	37.21			57.62		cervids
5604	L	32.54	32.90		32.64	54.75	52.22	cervids
5445	R	31.03	29.54		28.97		49.66	
3569	R	32.64	32.96		31.71	54.91	52.73	
5179	R	35.99	34.13		32.87	61.49	56.84	
2918	R	32.53			30.77	54.01	48.34	cervids
2918	L	32.17	32.73		30.57	54.12	49.23	

Appendix 4. Mesurements of the distal tibia of Udunga artiodactyls used in this report.

Udg-	side	Dtl	Dtm	Bfd	Bias	memo1
4015	R	40.08	32.45	51.51	36.46	cervids
4203	R	45.23	34.98	57.30	38.32	*Alces*?
2791	R	44.76	33.05	55.86	39.03	bovids
4783	R	39.81	33.01	51.24	36.04	bovids
3648	R	33.88	28.35	47.29	35.08	bovids
2221	R	39.45	31.50	48.85	36.38	bovids
4034	R	42.03	30.49	50.43	34.93	bovids
5175	R	44.19	32.28	52.70	36.10	bovids
4013	R	37.24	29.57	50.23	34.21	bovids
3644	R	39.38	30.47	49.99	33.53	bovids
3988	R	33.72	27.97	45.66	32.59	bovids
5703	R	41.44	30.06	47.39	33.63	bovids
3625	R	32.83	26.16	43.74	32.55	bovids
3631	R	29.05	22.95	34.69	23.70	bovids
3118	R	31.50	23.65	38.12	27.26	bovids
5507	R	29.49	22.83	38.42	26.46	bovids
3065	R	32.87	24.36	39.77	27.82	bovids
5506	R	35.78	31.50	43.41	32.52	bovids
2226	R	32.52	24.40	39.50	29.10	bovids
5705	R	32.20	26.09	40.12	29.23	bovids
5704	R	36.43	28.64	45.21	33.06	bovids
3634	R	40.97			34.36	
3587	R	42.27	31.13		36.18	
3322	R	31.76	26.35		31.09	
4014	R		30.80		35.02	
3630	R	35.40	—		31.39	
2531	R	30.76	25.05		28.33	
4739	R		26.44		26.94	
5698	R	40.19	29.46	49.05	35.22	cervids
5310	R	44.96	34.71	55.30	37.55	*Alces*?
5697	R	44.36	32.82	55.37	38.42	cervids
4204	R	45.17	34.24	52.23	37.40	cervids
3395	R	42.98	29.91	50.85	35.86	cervids
4044	R	39.30	28.81	46.80	34.10	cervids
5309	R	39.32	29.23	46.65	33.62	cervids
5503	R	40.19	28.97	48.40	34.83	cervids
3385	R	35.59	28.77	44.89	32.49	cervids
4784	R	40.58	29.48	49.77	36.39	cervids
4205	R	40.66	30.47	49.25	34.76	cervids
5700	R	40.42	31.47	48.79	35.84	cervids
5308	R	38.38	30.10	48.54	34.74	cervids
5702	R	39.18	28.68	46.75	33.58	cervids
5306	R	39.33	29.97	47.82	35.38	cervids
4959	R	39.25	27.85	47.03	32.71	cervids
2224	R	40.90	29.46	48.34	35.18	cervids
3652	R	43.02	30.70	51.36	35.65	cervids
5501	R	40.29	29.90	47.86	33.89	cervids
5504	R	38.40	29.57	48.16	34.57	cervids
3649	R	31.90	25.17	42.38	30.09	cervids
3646	R	42.88	31.15	51.71	37.17	cervids
4033	R	39.03	29.40	46.10	34.60	cervids
5303	R	38.18	29.09	48.58	33.96	cervids
4961	R	39.27	28.60	47.71	33.18	cervids
5508	R	30.50	24.86	41.52	27.93	cervids
4509	R	42.12	31.34	51.76	36.32	cervids
4276	R	42.74	31.04	51.15	37.63	cervids
3626	R	42.68	29.79	53.24	36.61	cervids
4506	R	42.78	30.17	52.05	32.78	cervids
3351	R	41.49	32.27	52.19	33.44	cervids
3632	R	40.74	29.35	48.71	34.37	cervids
2223	R	41.61	29.89	51.35	36.30	cervids
5502	R	40.54	29.76	49.75	34.67	cervids
4510	R	41.88	30.83	50.83	33.01	cervids
5699	R	40.26	29.46	50.06	35.44	cervids
4277	R	39.26	30.23	50.38	35.95	cervids
4287	R	27.10	21.80	37.28	25.28	cervids
4206	R	40.32	28.16	48.63	33.34	cervids
3655	R	28.40	22.16	37.34	26.53	cervids
5302	R	28.28	23.23	38.36	26.26	cervids
5706	R	37.91	28.48	45.31	31.60	cervids
3307	L	49.00	37.23	62.54	43.68	*Alces*?
4960	R		30.25	51.10	33.74	
5511	R		27.86		29.63	
2790	R	40.96		49.89		
4208	R	40.23	30.80	48.40	34.96	
4785	R		28.50	48.53	32.17	
3374	R	42.35			35.73	
4507	R	44.45		52.80	37.63	
4505	R	41.63	31.26			
4508	R	41.99	31.54		37.62	
4963	R	39.47	28.87		32.99	
3152	R	29.74	21.45		24.82	
3635	L	47.27	37.12	59.54	43.31	bovids
3314	L	40.71	30.91	52.92	36.72	bovids
5585	L	40.23	29.71	48.98	37.34	bovids
5312	L	35.92	28.31	46.23	32.55	bovids
4948	L	37.84	31.31	50.89	32.18	bovids
3640	L	38.72	30.96	49.10	34.45	bovids
3306	L	33.30	26.98	42.16	29.41	bovids
3328	L	33.65	26.04	40.61	29.27	bovids
3077	L	35.20	27.75	43.80	30.03	bovids
3330	L	34.68	28.20	41.46	29.25	bovids
4951	L	32.43	26.57	43.14	32.34	bovids
4501	L	31.28	23.02	40.16	28.54	bovids
1955	L	32.98	23.94	41.03	28.43	bovids
5707	L	32.82	23.81	40.84	26.96	bovids
4110	L	27.48	21.55	35.92	25.78	bovids
3160	L	29.02	22.44	37.00	25.35	bovids
4277	L	27.49	19.90	35.88	24.14	bovids
5305	L	27.54	20.38	34.45	24.46	bovids
4499	L	37.81	27.74		34.99	
4279	L		25.99	39.87	28.99	
5515	L		27.78		30.19	
3628	L	30.35	25.64		26.77	
3305	L			50.72	37.75	
3150	L		24.61	39.88	26.62	
3629	L			48.84		
4038	L	32.97	24.68		30.13	
4051	L	29.68	23.22		26.25	
3989	L	42.19	30.71	51.42	35.21	cervids
4041	L	42.84	30.75	49.64	36.04	cervids
4040	L	41.32	29.32	51.09	34.79	cervids
4278	L	39.63	30.98	50.85	35.33	cervids
3650	L	40.06	28.23	49.01	35.85	cervids
4498	L	44.13	31.83	53.76	36.60	cervids
2222	L	41.61	28.62	50.33	35.04	cervids
5513	L	43.19	32.60	52.22	35.56	cervids
4947	L	41.92	30.61	50.88	34.70	cervids
4786	L	42.51	29.72	51.35	34.17	cervids
4952	L	42.20	32.10	50.75	35.72	cervids
4949	L	38.73	28.63	48.94	32.94	cervids
4209	L	37.71	29.74	47.45	33.03	cervids
3375	L	38.74	31.78	49.92	36.06	cervids
3627	L	37.41	29.20	46.64	34.70	cervids
4956	L	37.66	28.68	47.56	32.14	cervids
5512	L	41.82	28.38	49.51	34.47	cervids
3465	L	37.03	29.22	46.16	32.26	cervids
3103	L	35.93	25.91	42.17	30.52	cervids
4037	L	31.31	23.59	40.33	27.98	cervids
5708	L	38.47	27.73	46.02	32.35	cervids
5516	L	38.54	28.33	45.72	32.70	cervids
4950	L	38.15	29.72	48.43	33.21	cervids
4290	L	30.44	22.83	38.21	24.88	cervids
2918	L	38.72		47.50	33.73	cervids
3356	L				24.30	
3638	L	40.20	31.01		34.84	
5514	L		29.98	51.46	34.77	
3639	L	40.81	31.23		35.52	
4731	L		31.38	50.35	35.36	
2225	L	41.16	30.85		35.46	
5311	L		28.84	45.94	33.11	
4787	L	40.87	29.05		33.85	
3642	L		28.08	47.02	34.26	
4788	L	40.74	29.62	49.51	34.64	cervids/bovids
3657	L	42.04	32.31	50.55	37.39	cervids/bovids
4502	L	42.51		50.91		cervids/bovids
3624	L	41.91	31.62		25.01	cervids/bovids
4015	L		27.25			cervids/bovids
4210	L		28.21		35.62	
4211	L					
4039	L	42.32				
3651	L			44.26	33.02	
4036	L				33.22	
4042	L					
3380	L					
3558	L					
3836	L			49.54	34.26	articulated
5169	L	42.03			34.65	articulated
2227	R	24.97	20.27	31.63	21.73	*Capreolus*
5314	R	23.06	19.33	30.16	20.27	*Capreolus*
3653	R	22.96	18.66	28.94	21.20	*Capreolus*
3658	R	23.57	18.17	28.54	20.96	*Capreolus*
4964	R	26.51	20.99	35.54	23.67	*Capreolus*
4965	R	25.52	20.27	33.86	22.64	*Capreolus*
3656	R	26.93	19.76	32.10	22.85	*Capreolus*
3659	R	26.60	19.61	34.57	21.60	*Capreolus*
3647	R	24.89	20.35	33.16	24.05	*Capreolus*
3331	R	25.36	21.05	32.34	21.99	*Capreolus*
3398	R	25.21	19.17	33.17	22.15	*Capreolus*
4958	L	27.12	20.21	34.80	24.65	*Capreolus*
5313	L	22.95	18.13	29.49	19.11	*Capreolus*
3654	L	23.10	16.75	28.23	18.42	*Capreolus*
3657	L	21.65	17.42	28.65	19.70	*Capreolus*
5317	L	23.41	18.66	26.65	19.16	*Capreolus*
5316	L	26.11	20.73	32.29	24.74	*Capreolus*
5319	L	24.96	19.93	31.23	20.26	*Capreolus*
3324	L	23.31	17.65	27.87	20.77	*Capreolus*
3581	L	26.43	20.74	30.47	23.24	*Capreolus*
5790	L	23.12	19.58	30.13	22.19	*Capreolus*
5320	L	24.83	21.11	31.96	22.39	*Capreolus*
5518	L	24.14	19.50	31.23	23.01	*Capreolus*
4503	L	26.98	20.67	32.05	23.24	*Capreolus*
4724	L	24.59	19.23	30.67	22.35	*Capreolus*
5517	L	31.80	26.51	36.25	28.96	*Capreolus*
3353	L	21.32	17.80	28.39	18.73	*Capreolus*
4512	R		18.01		20.19	*Capreolus*
5307	R					*Capreolus*
4065	R					*Capreolus*
4966	R					*Capreolus*
4723	R					*Capreolus*
4967	R					*Capreolus*
5510	R	23.46			22.34	*Capreolus*

Appendix 5. Mesurements of the calcaneus specimens of Udunga artiodactyls used in this report.

Udg-	side	H1	H2	H3c	B1	B2	SDct	Cx1	Cx2	Cx3	taxon
3128	L	114.58	80.77	38.94	36.69	41.67	28.58	28.46	40.21	20.49	
4932	L	112.75	80.65	38.64	38.27	42.41	28.88	26.18	40.10	21.24	
5635	L	118.40	84.01	41.52	36.59	43.73	30.02	28.14	46.69	25.97	
5179	R	122.57	88.79	38.53	37.98	47.46	32.10	30.97	45.82	30.14	
2521	R	80.43	57.74	24.32	28.10	31.62	19.85	18.79	30.99	18.36	*Capreolus*
2766	R	77.24	55.70	22.76	25.30	29.91	18.45	18.90	29.00	46.07	*Capreolus*
4521	R	135.98	99.92	47.14	41.77	49.21	35.85	33.01	47.27	27.72	
4935	R	120.69	85.56	44.14	36.40	43.66	30.36	27.72	46.32	28.09	
3555	R	131.54	94.91	47.10	38.83	49.16	32.02	31.76	49.28	30.86	
4931	R	121.94	87.58	41.77	34.33	47.80	30.22	28.91	46.29	27.36	
4933	R	118.91	87.10	42.58	33.97	46.54	30.88	28.39	42.50	25.63	
2245	R	117.24	85.93	41.48	36.20	42.63	29.52	27.91	43.11	25.56	
5638	L	127.18	90.73	41.26	38.62	45.61	32.77	29.30	47.22	29.27	
3476	L	119.31	87.05	40.17	35.48	45.50	31.39	26.39	41.94	25.36	
4592	R	120.68	88.98	42.31	41.34	47.57	31.07	38.46	47.69	31.73	
3113	R	111.32	80.83	42.96	35.77	42.95	27.94	26.42	41.48	25.19	
4939	R	117.92	84.96	43.10	38.05	45.65	30.39	26.81	45.09	25.64	
4940	R	114.79	84.37	38.02	38.60	43.03	29.57	25.78	40.93	23.73	
4926	R	119.37	86.42	40.59	34.95	41.73	30.22	28.09	44.54	25.62	
4254	R	108.89	78.03	41.04	34.37	40.06	25.88	25.65	40.49	23.70	
5636	L			39.88	38.67	46.58	29.82	28.80	46.23	25.99	
3921	L			38.24	42.30	44.19	27.36	27.31	45.02	25.76	
4927	R			43.26	35.21	44.32	29.51	29.75	47.21	26.72	
4252	R			40.83	37.54	41.67	26.38	27.62	42.96	23.52	
4594	L			39.77	39.38	45.43	30.88	28.29	46.75	25.67	
2918	L			32.79	35.84	42.85		25.75	41.33	23.59	
4942	L			41.54	34.95	44.30		27.11	42.79	23.34	
4930	L			39.88	35.95	41.79		26.48	42.90	27.24	
3776	L			38.28	35.42	42.36		27.57	42.79	25.31	
3785	L			42.62	42.37	46.30		29.41	45.33	25.94	
4946	L			40.28	33.60	40.78		27.90	41.95	25.22	
3775	L	87.25	64.89	31.97	29.42		21.20	22.93	33.25	19.33	*Capreolus*
5633	L	85.23	63.46	27.55	27.91		22.22	21.13	30.77	19.05	*Capreolus*
5606	L			42.08	33.30	40.85	26.24		43.88	25.59	
5445	R	109.49	80.92		33.82		28.32	24.64			
4694	L	82.96	57.43	30.77	27.82	32.55	19.99	23.78	32.78	17.55	*Capreolus*
3918	R		61.41		27.64		21.89				
3790	L	131.23	95.00		42.71		33.41	30.64			
4748	L		96.97				33.27				
4944	L			35.82	32.83	43.79	26.48	25.94			
3126	R	120.83	86.42	42.72	34.91	44.38	31.24	30.77			
3483	R			40.54	35.72	45.64		28.64	43.53	25.74	
4934	R			26.92		45.73		28.17	42.97	25.67	
4945	L		54.82				18.80				
3457	L		56.38				18.01				
4593	R							28.72			

Appendix 6. Mesurements of the naviculocuboid specimens of Udunga artiodactyls used in this report.

Udg-	side	Dnc	B1nc	B2nc	Hnc	Xnc	taxon
3925	R	43.60	47.69	37.99	38.77	26.60	
4582	R	38.03	46.60	38.90	34.54	26.36	
4825	R	40.95	47.39	38.03	36.00	25.74	*Capreolus*?
5183	R	36.92	42.66	34.56	33.05	24.21	
5488	R	37.51	42.71	35.20	33.58	24.90	
4822	R	35.46	41.89	34.54	30.08	25.33	
4827	R	34.63	41.78	33.85	30.41	25.92	
4821	R	35.87	40.85	32.15	33.26	25.13	
4826	R	34.82	41.12	32.47	31.32	23.68	
5181	R	34.14	41.57	34.86	32.72	23.85	
4824	R	35.74	42.03	34.21	32.82	25.01	
5489	R	36.25	42.01	33.72	31.91	25.05	
3928	R	34.74	40.07	33.18	30.16	23.78	
4332	R	35.79	42.44	33.70	30.86	23.98	
3990	R	33.46	41.82	34.63	30.05	24.63	
5180	R	35.59	40.29	31.00	29.31	24.73	
2230	R	34.84	42.08	34.59	29.37	23.31	
3992	R	36.05	41.57	33.76	30.24	24.82	
3577	R	31.26	39.94	33.07	23.90	21.78	
2235	R	26.92	31.45	24.19	21.00	16.69	
3597	R	25.98	26.42	20.85	21.26	15.02	*Capreolus*
4828	R	21.42	26.93	21.83	15.59	15.94	*Capreolus*
5184	L	41.51	45.83	36.48	34.43	26.70	
5492	L	37.22	42.70	35.76	34.26	26.23	
4820	L	37.98	43.62	35.63	32.72	24.29	
4583	L	38.18	44.31	36.78	33.72	26.80	
2234	L	37.34	45.06	35.57	33.24	26.63	
3993	L	38.85	44.35	36.42	32.71	26.82	
5677	L	37.07	42.05	33.07	32.51	24.50	
2229	L	35.52	42.13	33.44	31.43	24.68	
3599	L	34.35	42.22	35.18	30.69	26.36	
3294	L	37.40	45.36	35.80	33.98	26.35	
2232	L	36.50	42.86	34.27	32.59	24.69	
4813	L	34.49	41.48	33.42	30.75	24.53	
2233	L	35.32	42.05	34.62	32.29	25.68	
2231	L	37.76	44.85	37.01	34.48	26.64	
4581	L	37.57	45.15	34.66	35.01	25.88	
3292	L	32.50	39.59	32.70	30.06	23.84	
5490	L	31.92	38.75	31.80	29.86	23.23	

Udg-	side	Dnc	B1nc	B2nc	Hnc	Xnc	taxon
3068	L	27.66	34.54	26.47	20.94	18.85	
3994	L	28.78	36.64	29.76	22.84	20.07	
3293	L	25.99	32.98	26.07	21.70	17.21	
5493	L	39.57	43.78	32.69	31.63	24.87	
5765	L	21.76	24.01	19.58	17.46	15.02	
5604	L	40.80	43.24	33.40	33.14	24.90	
4888	L	42.45	44.14	34.01	35.17	25.15	
5185	L	37.36	42.80	34.02	32.17	27.38	
3611	L	27.07	27.53	21.83	19.63	17.57	*Capreolus*
5187	L	23.51	24.04	19.49	17.64	11.80	*Capreolus*
2918	L	38.21	39.76	32.69	30.45	23.77	articulated
5179	R	39.70	42.73	35.32	32.05	25.22	articulated
5445	R			27.59		22.13	articulated
3727	R	34.27	41.69	34.02		22.99	
5182	R	36.52	42.74	34.19		24.29	
3543	R	33.76	41.31	33.27		23.14	
3008	R	36.48	42.27	34.68		22.98	
3296	R	30.07	37.81	31.48		20.14	
3991	L	42.17	50.75	42.26		30.64	
5494	L	36.56	43.68	34.58		25.63	
4066	R	26.72	28.50	22.37		16.86	
3926	R	33.96	39.57	32.17		22.83	
3929	L	37.31			35.62		
3563	L	37.73	43.53	36.08		25.18	
5176	L	32.03			29.26	21.87	
5188	L		36.22	30.65			
4584	L	36.21	42.77	34.27		24.40	
3290	L	35.43	42.53	34.59		25.23	
4817	L	37.03	42.39	34.56		23.25	
4818	L	32.84	41.11	32.82		24.52	
5495	L	33.70	32.45	32.45		25.76	
3847	L		38.03	30.71	28.56	22.97	
3569	L	38.03	39.91	32.51		24.82	
3297	L	37.69	44.97	35.92	31.98	26.90	
5491	L	35.20	42.17	34.16	30.36	22.85	
5186	L	34.07	41.76	34.72	32.37	23.70	
3421	L	36.27	43.08	35.44	34.42	25.54	
2863	L	28.81	34.74	27.92	22.16	19.47	
2235	R	28.23	31.60	24.20	21.40	16.53	*Capreolus*